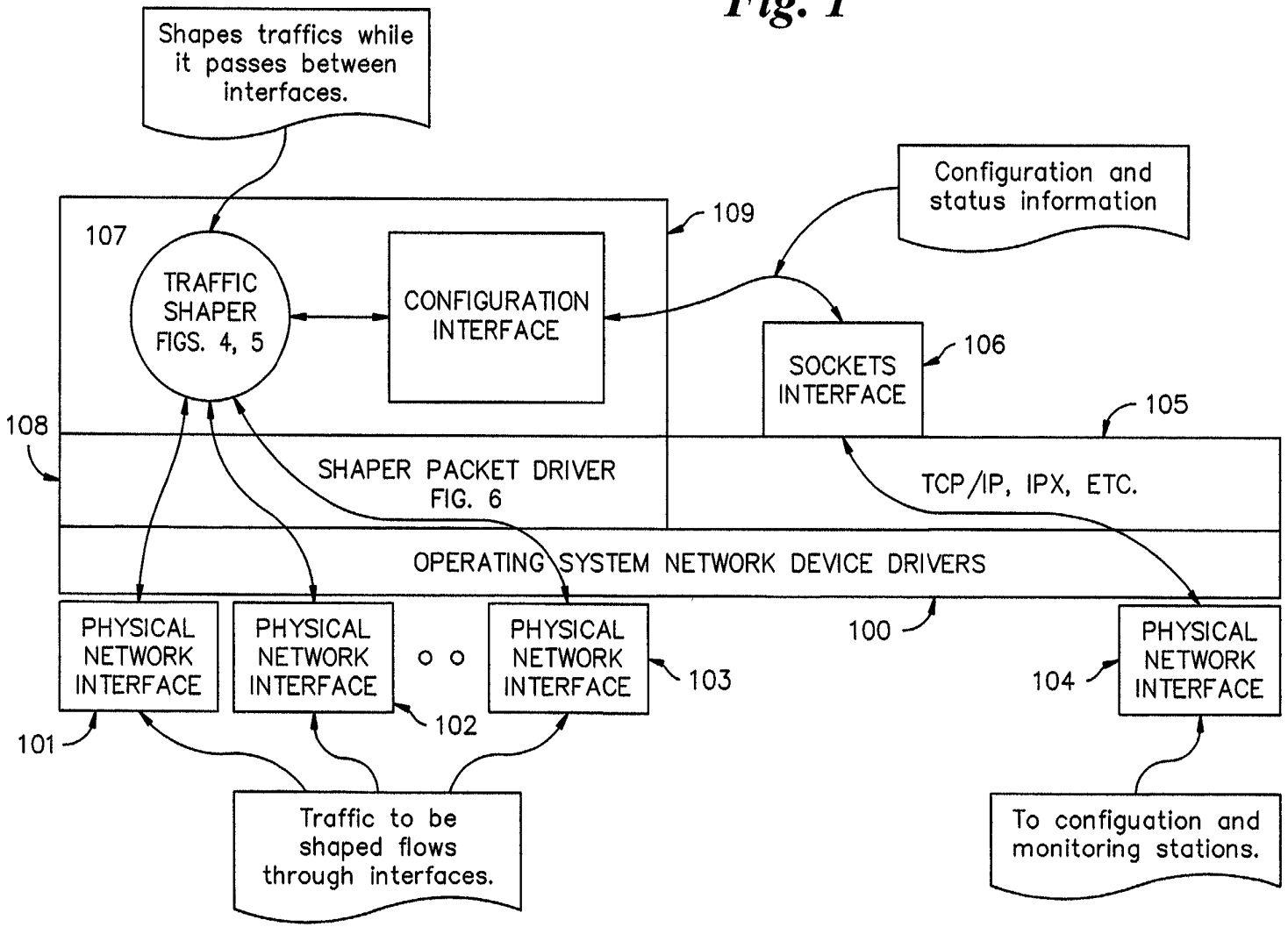
Fig. 1


Shapes traffics while it passes between interfaces.
Configuration and status information
107
109
TRAFFIC SHAPER FIGS. 4, 5
CONFIGURATION INTERFACE
SOCKETS INTERFACE
106
105
108
SHAPER PACKET DRIVER FIG. 6
TCP/IP, IPX, ETC.
OPERATING SYSTEM NETWORK DEVICE DRIVERS
PHYSICAL NETWORK INTERFACE
PHYSICAL NETWORK INTERFACE
o o
PHYSICAL NETWORK INTERFACE
103
100
104
PHYSICAL NETWORK INTERFACE
101
102
Traffic to be shaped flows through interfaces.
To configuation and monitoring stations.

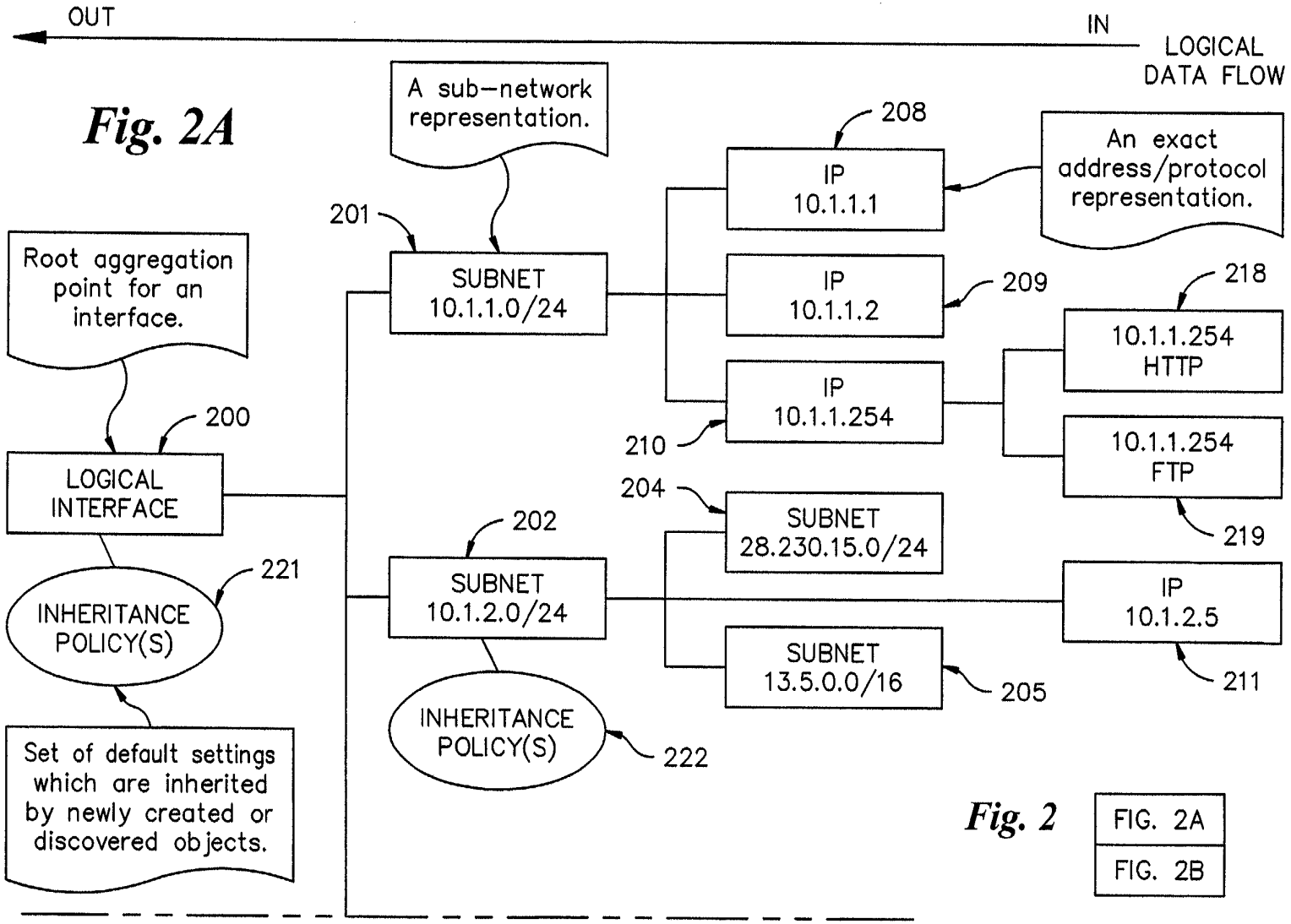
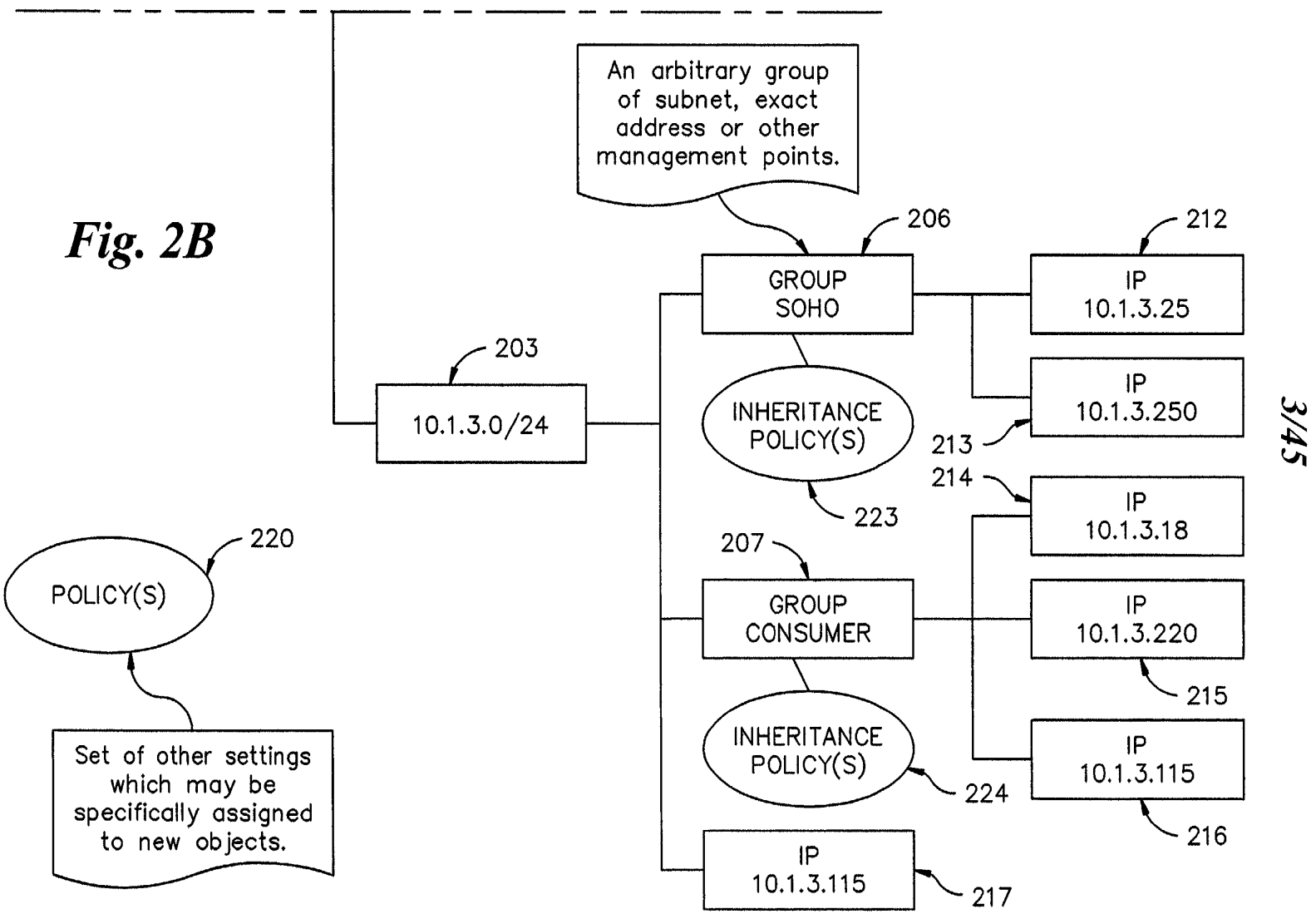


Fig. 2A

Fig. 2

FIG. 2A
FIG. 2B

Fig. 2B


An arbitrary group of subnet, exact address or other management points.
206
212
GROUP SOHO
IP 10.1.3.25
203
IP 10.1.3.250
INHERITANCE POLICY(S)
213
10.1.3.0/24
214
223
IP 10.1.3.18
207
220
GROUP CONSUMER
IP 10.1.3.220
POLICY(S)
215
INHERITANCE POLICY(S)
IP 10.1.3.115
224
Set of other settings which may be specifically assigned to new objects.
216
IP 10.1.3.115
217

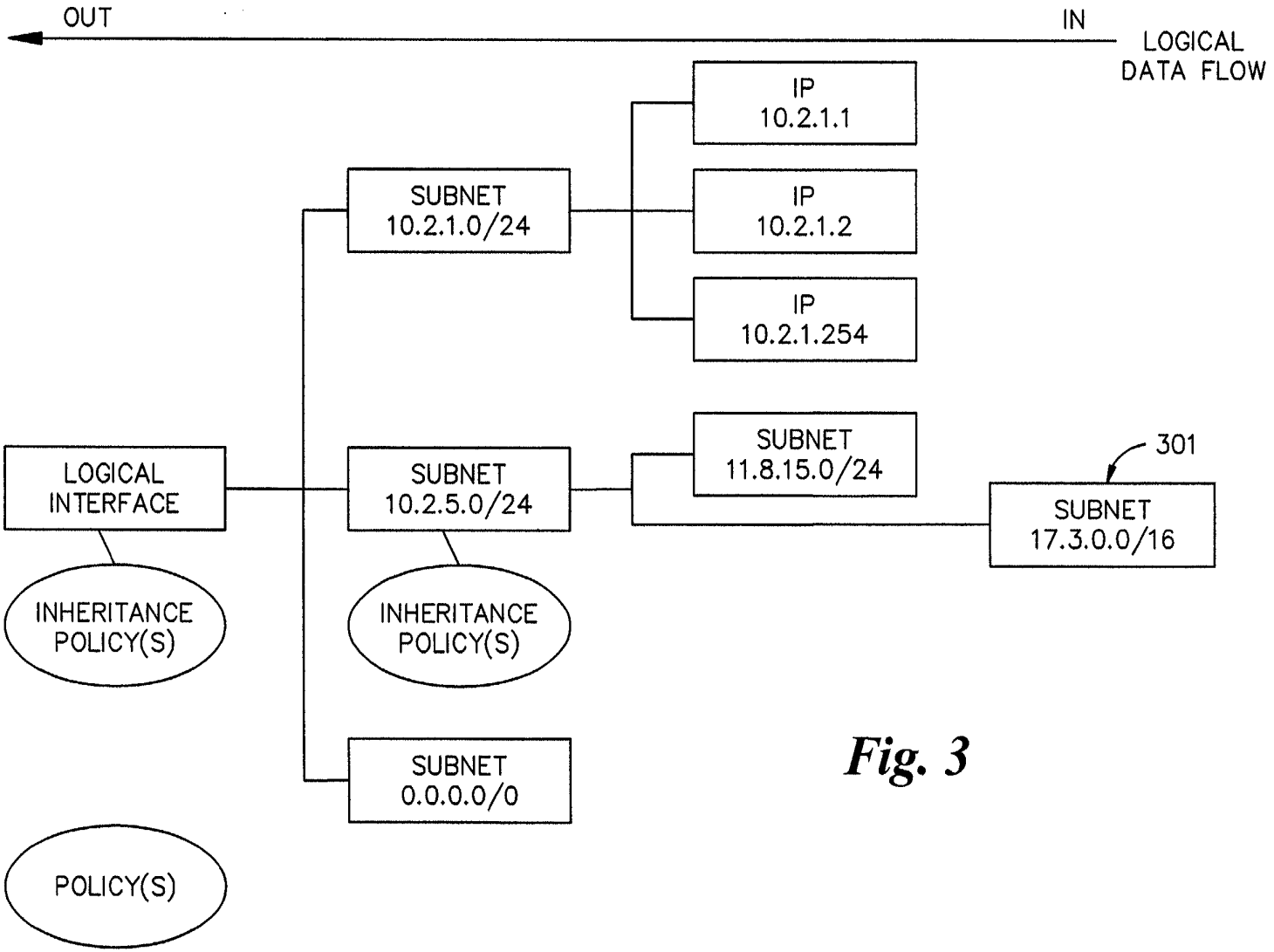
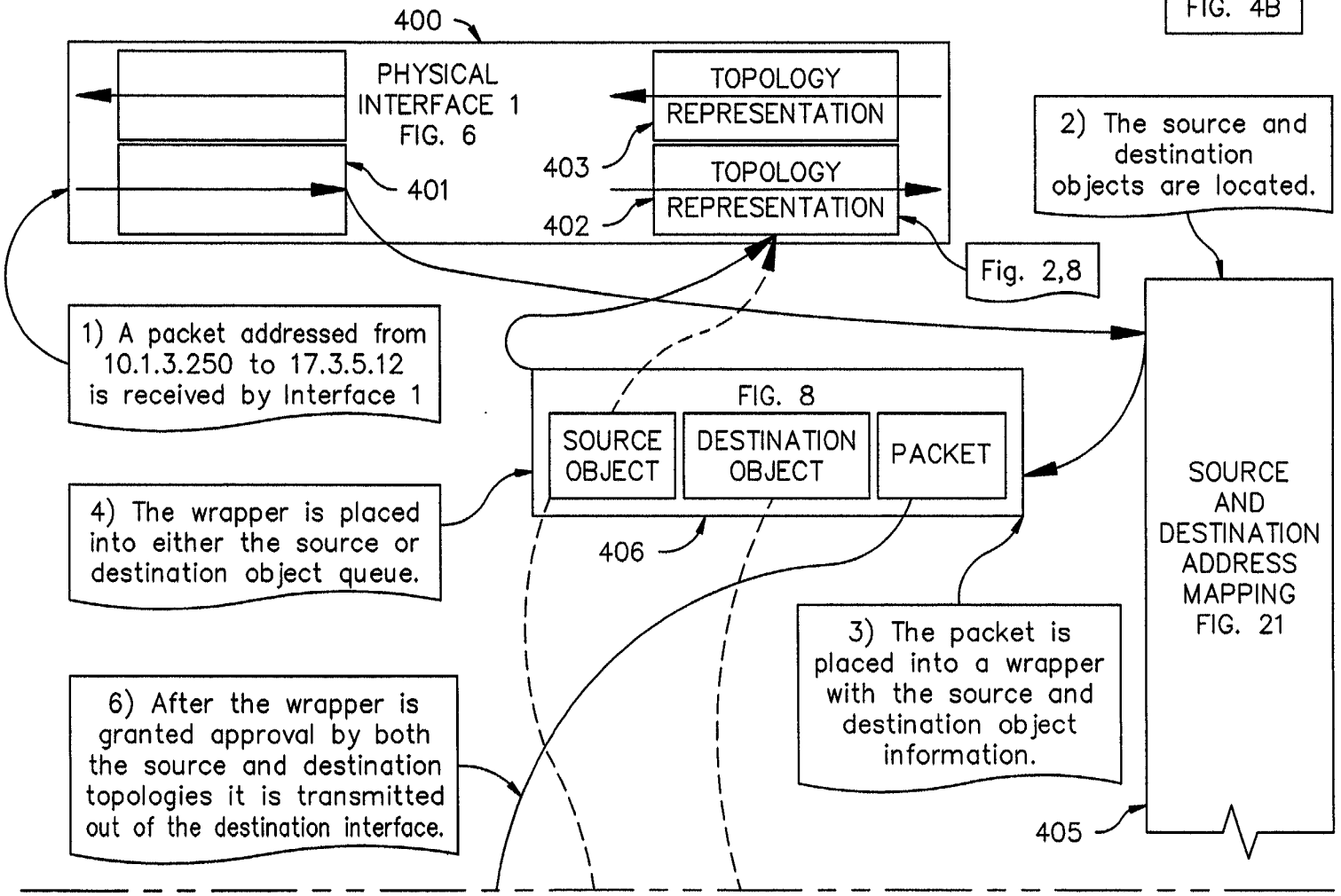

OUT
IN
LOGICAL
DATA FLOW
IP
10.2.1.1
SUBNET
10.2.1.0/24
IP
10.2.1.2
IP
10.2.1.254
SUBNET
11.8.15.0/24
301
LOGICAL
INTERFACE
SUBNET
10.2.5.0/24
SUBNET
17.3.0.0/16
INHERITANCE
POLICY(S)
INHERITANCE
POLICY(S)
SUBNET
0.0.0.0/0
POLICY(S)

Fig. 3

Fig. 4A

Fig. 4

FIG. 4A
FIG. 4B



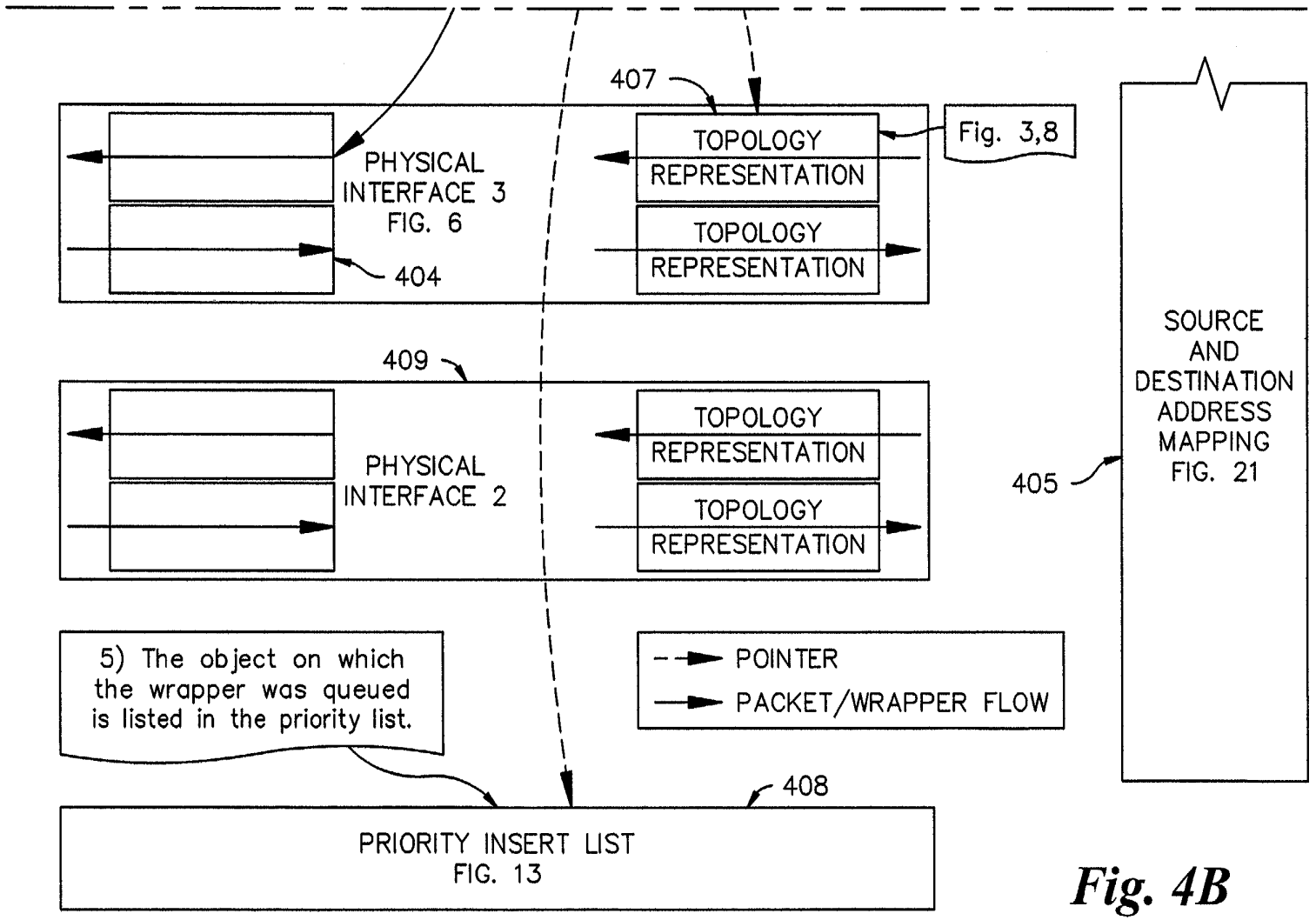
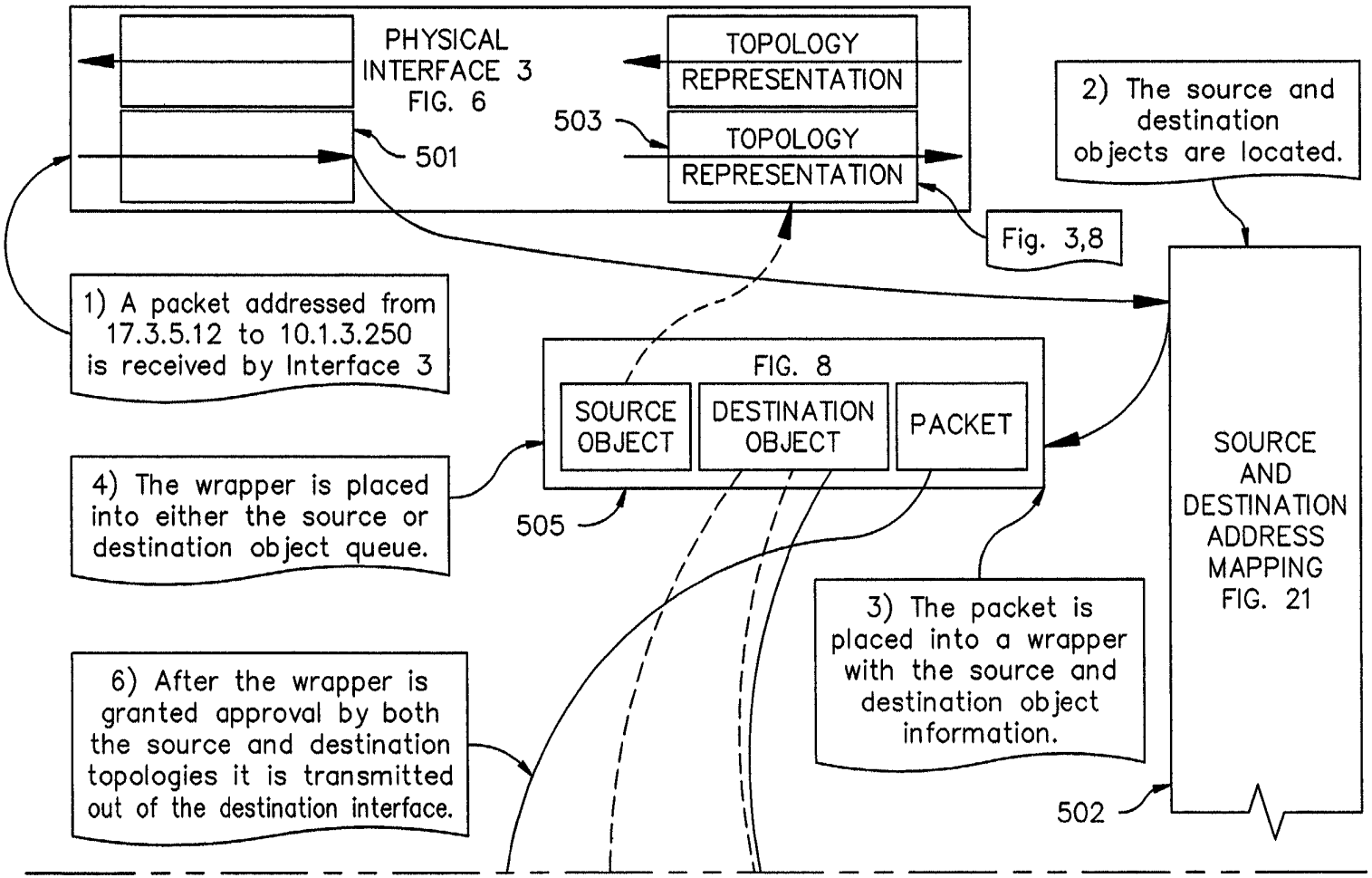

407
PHYSICAL INTERFACE 3 FIG. 6
404
TOPOLOGY REPRESENTATION
TOPOLOGY REPRESENTATION
Fig. 3,8
409
PHYSICAL INTERFACE 2
TOPOLOGY REPRESENTATION
TOPOLOGY REPRESENTATION
SOURCE AND DESTINATION ADDRESS MAPPING FIG. 21
405
5) The object on which the wrapper was queued is listed in the priority list.
POINTER
PACKET/WRAPPER FLOW
408
PRIORITY INSERT LIST FIG. 13

Fig. 4B

Fig. 5A

Fig. 5

FIG. 5A
FIG. 5B



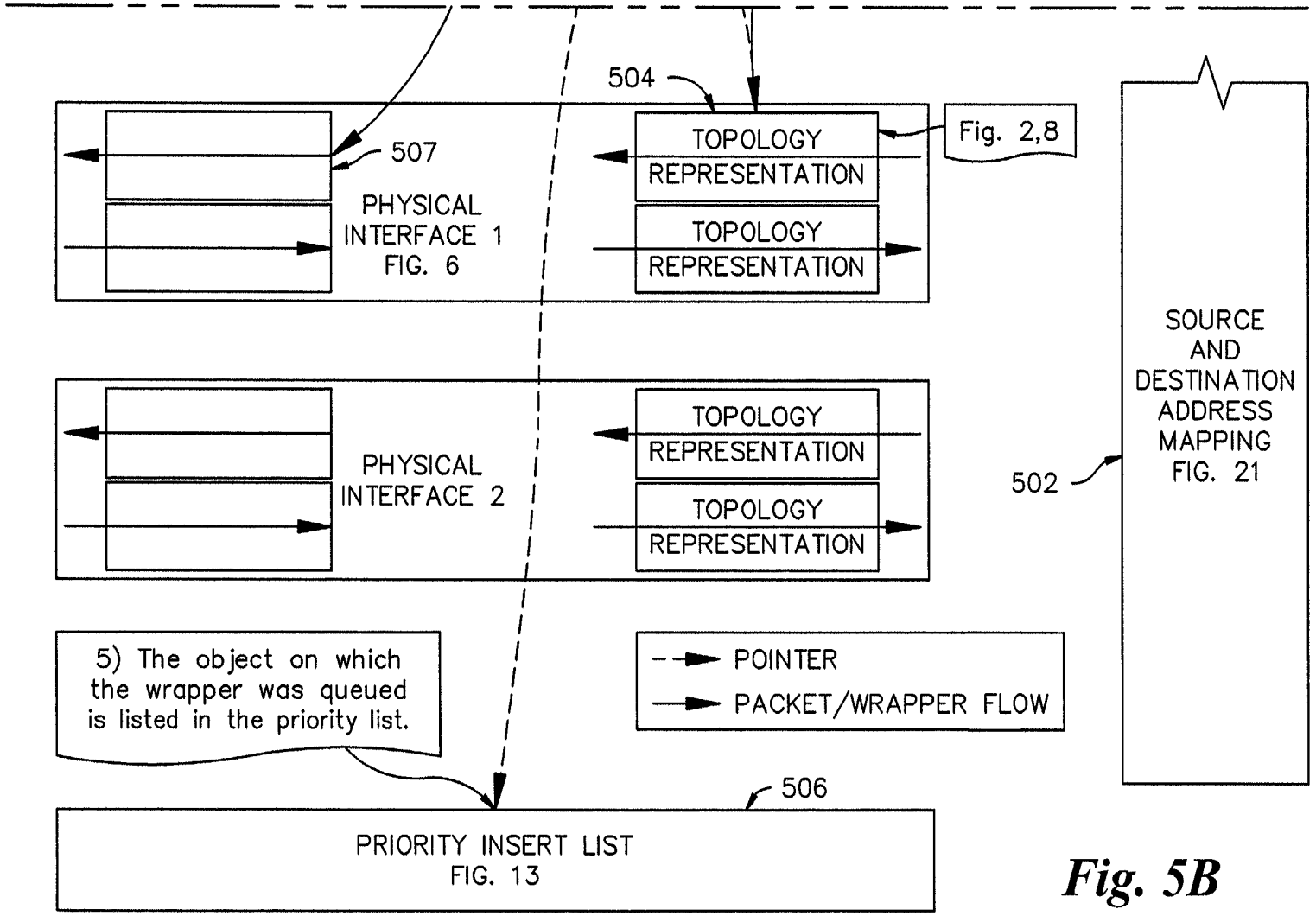

504
507
TOPOLOGY REPRESENTATION
Fig. 2,8
PHYSICAL INTERFACE 1 FIG. 6
TOPOLOGY REPRESENTATION
SOURCE AND DESTINATION ADDRESS MAPPING FIG. 21
PHYSICAL INTERFACE 2
TOPOLOGY REPRESENTATION
TOPOLOGY REPRESENTATION
502
5) The object on which the wrapper was queued is listed in the priority list.
POINTER
PACKET/WRAPPER FLOW
506
PRIORITY INSERT LIST FIG. 13

Fig. 5B

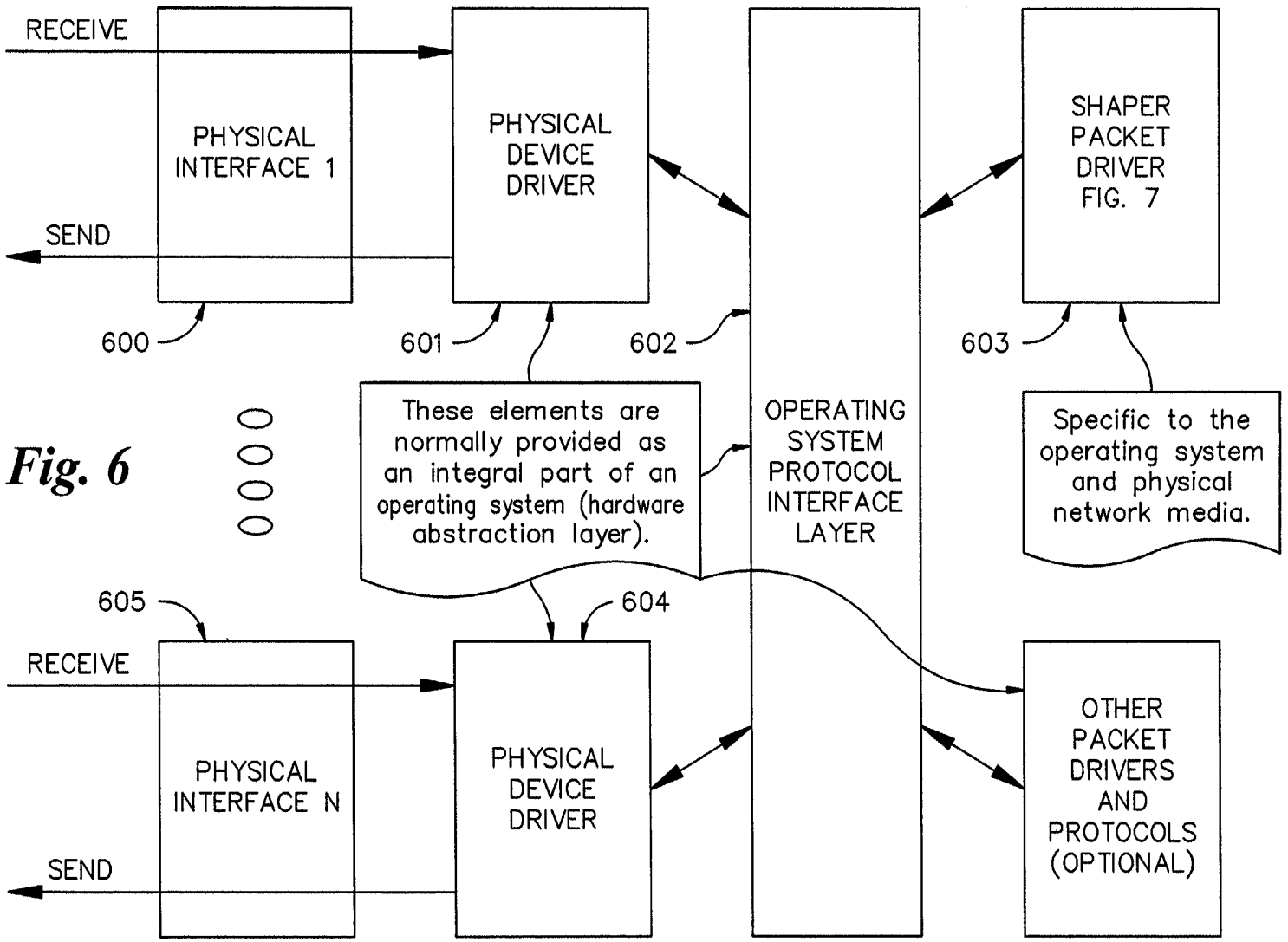

RECEIVE
PHYSICAL INTERFACE 1
SEND
PHYSICAL DEVICE DRIVER
SHAPER PACKET DRIVER FIG. 7
600
601
602
603
These elements are normally provided as an integral part of an operating system (hardware abstraction layer).
OPERATING SYSTEM PROTOCOL INTERFACE LAYER
Specific to the operating system and physical network media.
605
604
RECEIVE
PHYSICAL INTERFACE N
SEND
PHYSICAL DEVICE DRIVER
OTHER PACKET DRIVERS AND PROTOCOLS (OPTIONAL)

Fig. 6

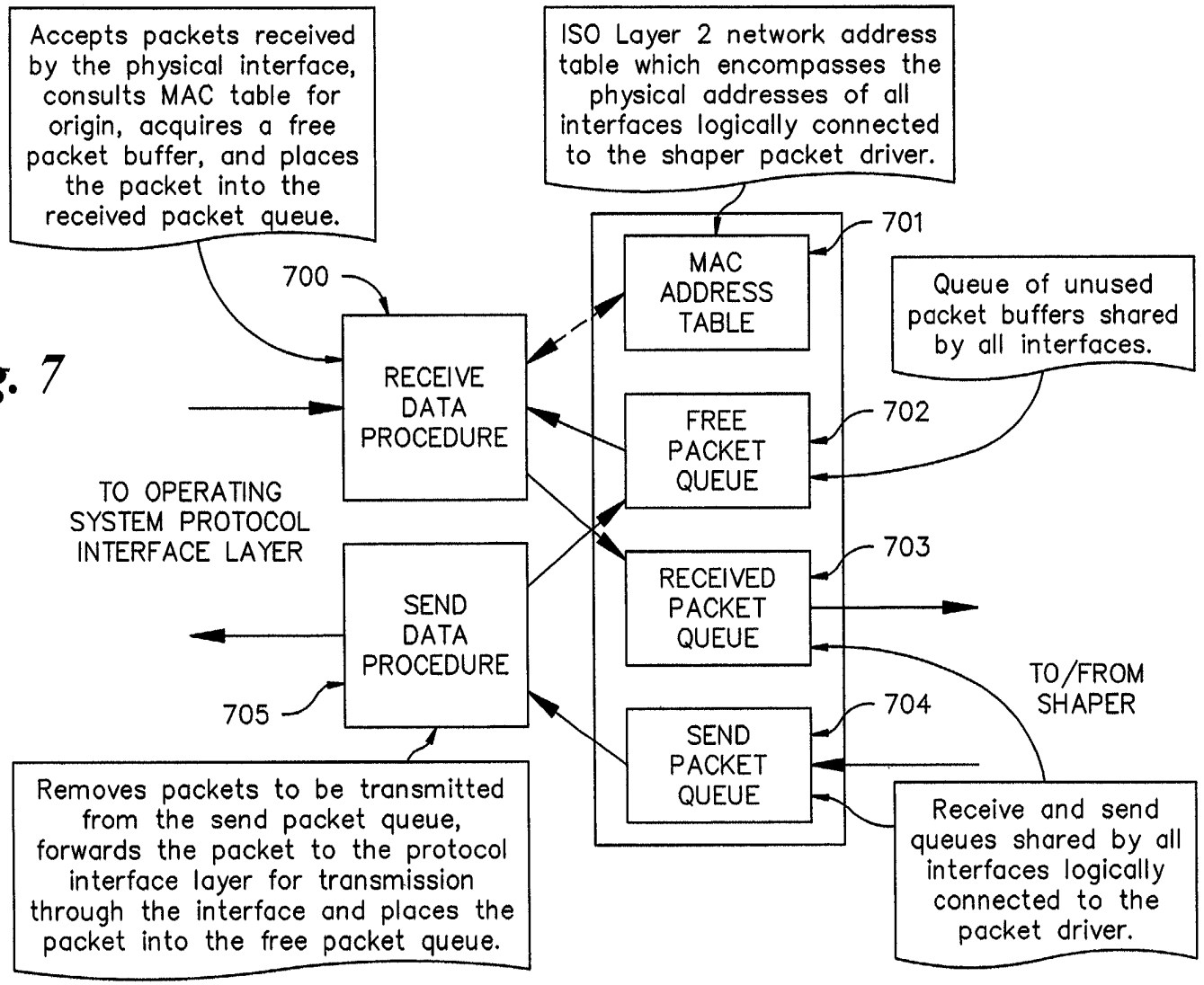

Accepts packets received by the physical interface, consults MAC table for origin, acquires a free packet buffer, and places the packet into the received packet queue.
ISO Layer 2 network address table which encompasses the physical addresses of all interfaces logically connected to the shaper packet driver.
700
701
MAC ADDRESS TABLE
Queue of unused packet buffers shared by all interfaces.
RECEIVE DATA PROCEDURE
FREE PACKET QUEUE
702
TO OPERATING SYSTEM PROTOCOL INTERFACE LAYER
RECEIVED PACKET QUEUE
703
SEND DATA PROCEDURE
TO/FROM SHAPER
705
704
SEND PACKET QUEUE
Removes packets to be transmitted from the send packet queue, forwards the packet to the protocol interface layer for transmission through the interface and places the packet into the free packet queue.
Receive and send queues shared by all interfaces logically connected to the packet driver.

Fig. 7

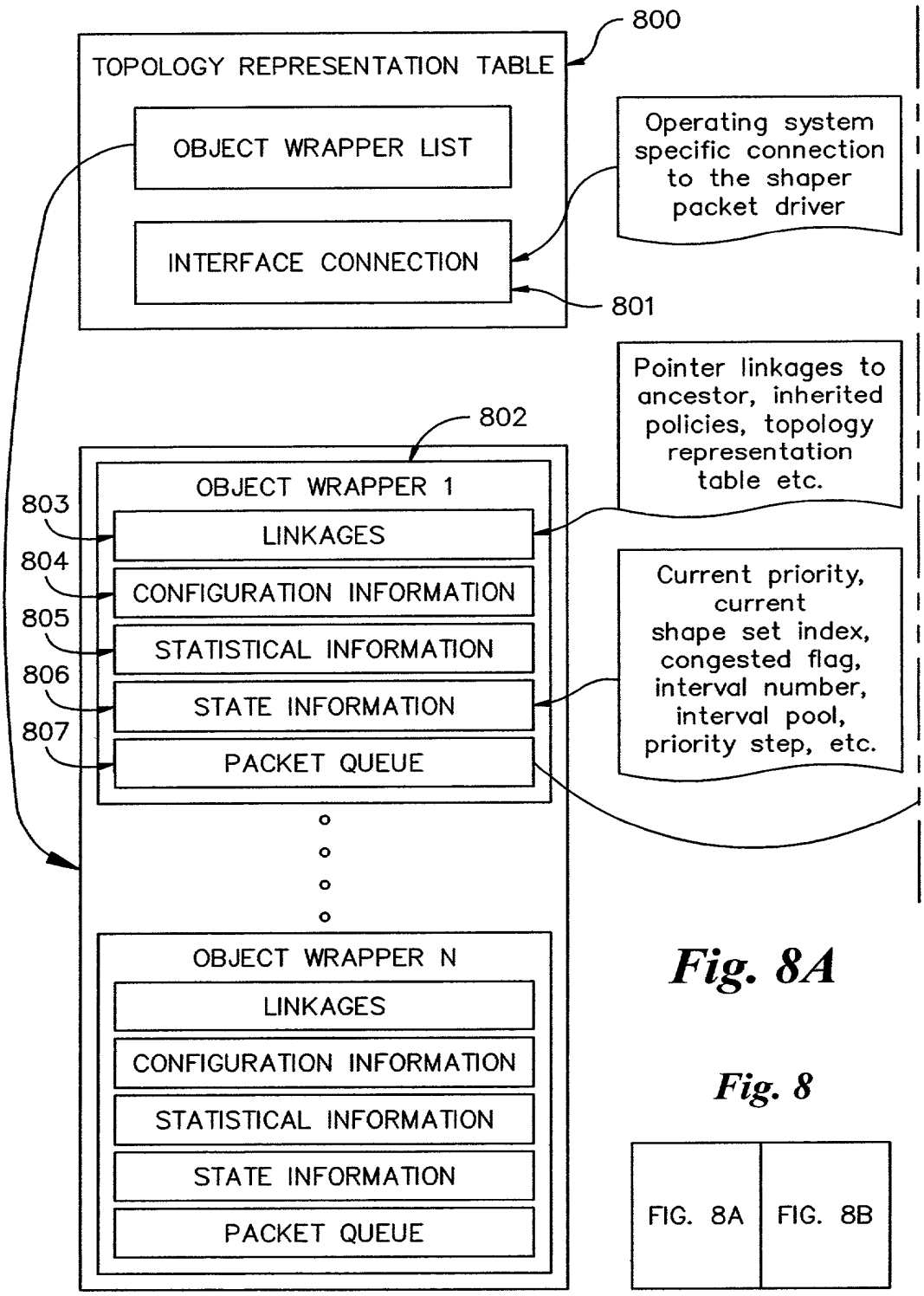


Fig. 8A

Fig. 8

FIG. 8A	FIG. 8B

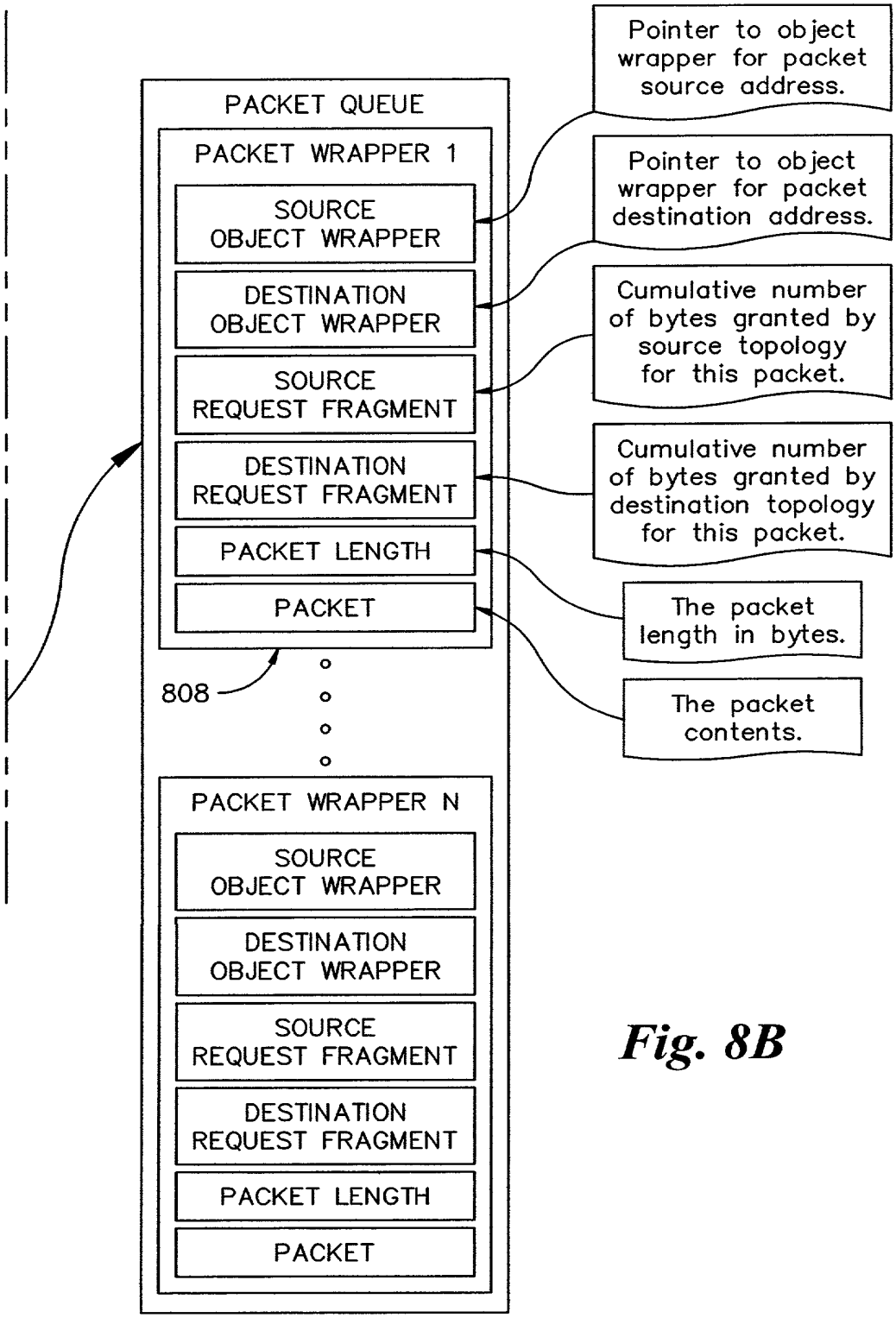

PACKET QUEUE
PACKET WRAPPER 1
SOURCE OBJECT WRAPPER
DESTINATION OBJECT WRAPPER
SOURCE REQUEST FRAGMENT
DESTINATION REQUEST FRAGMENT
PACKET LENGTH
PACKET
808
PACKET WRAPPER N
SOURCE OBJECT WRAPPER
DESTINATION OBJECT WRAPPER
SOURCE REQUEST FRAGMENT
DESTINATION REQUEST FRAGMENT
PACKET LENGTH
PACKET
Pointer to object wrapper for packet source address.
Pointer to object wrapper for packet destination address.
Cumulative number of bytes granted by source topology for this packet.
Cumulative number of bytes granted by destination topology for this packet.
The packet length in bytes.
The packet contents.

Fig. 8B

Fig. 9A

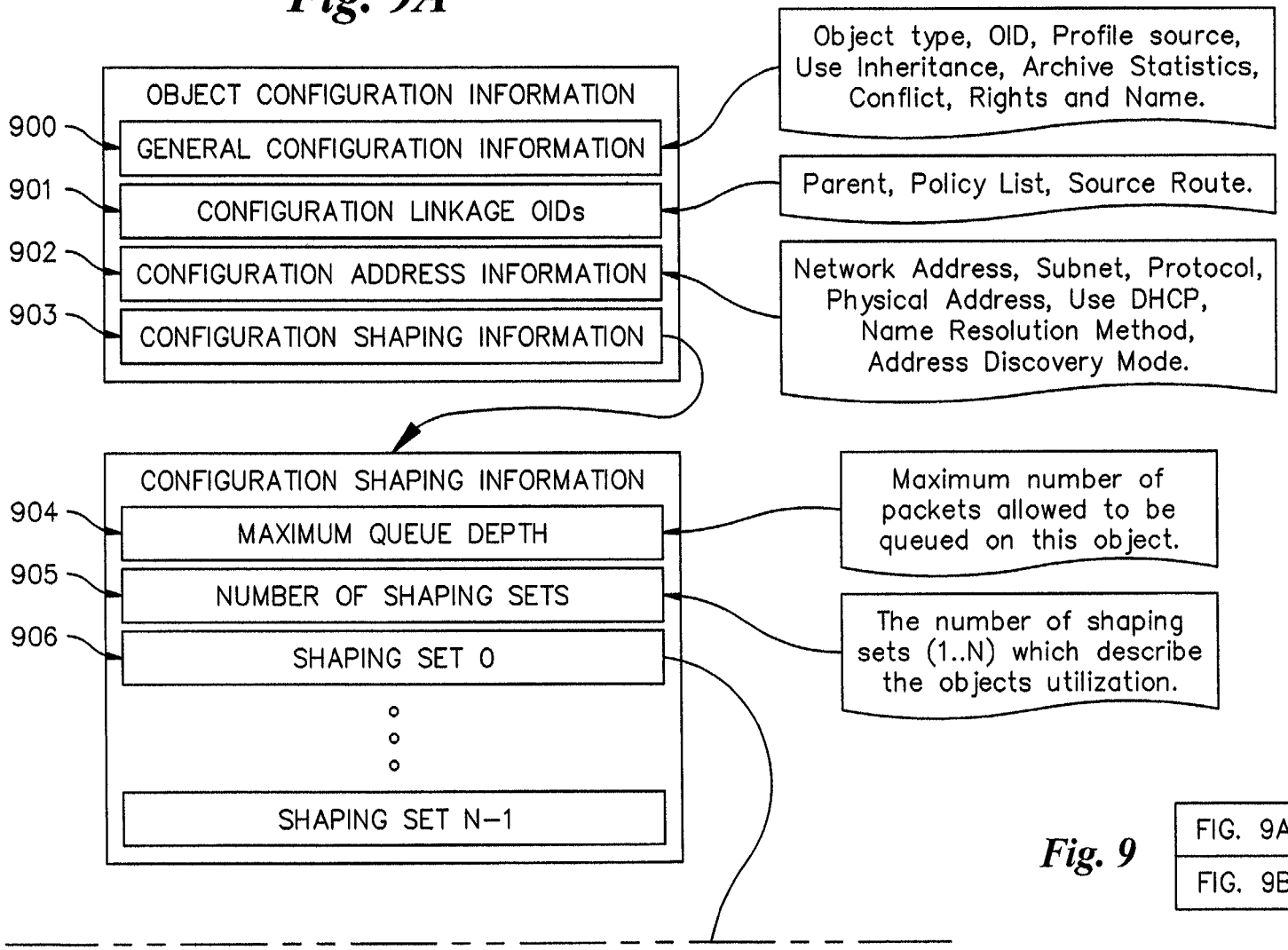


Fig. 9

FIG. 9A
FIG. 9B

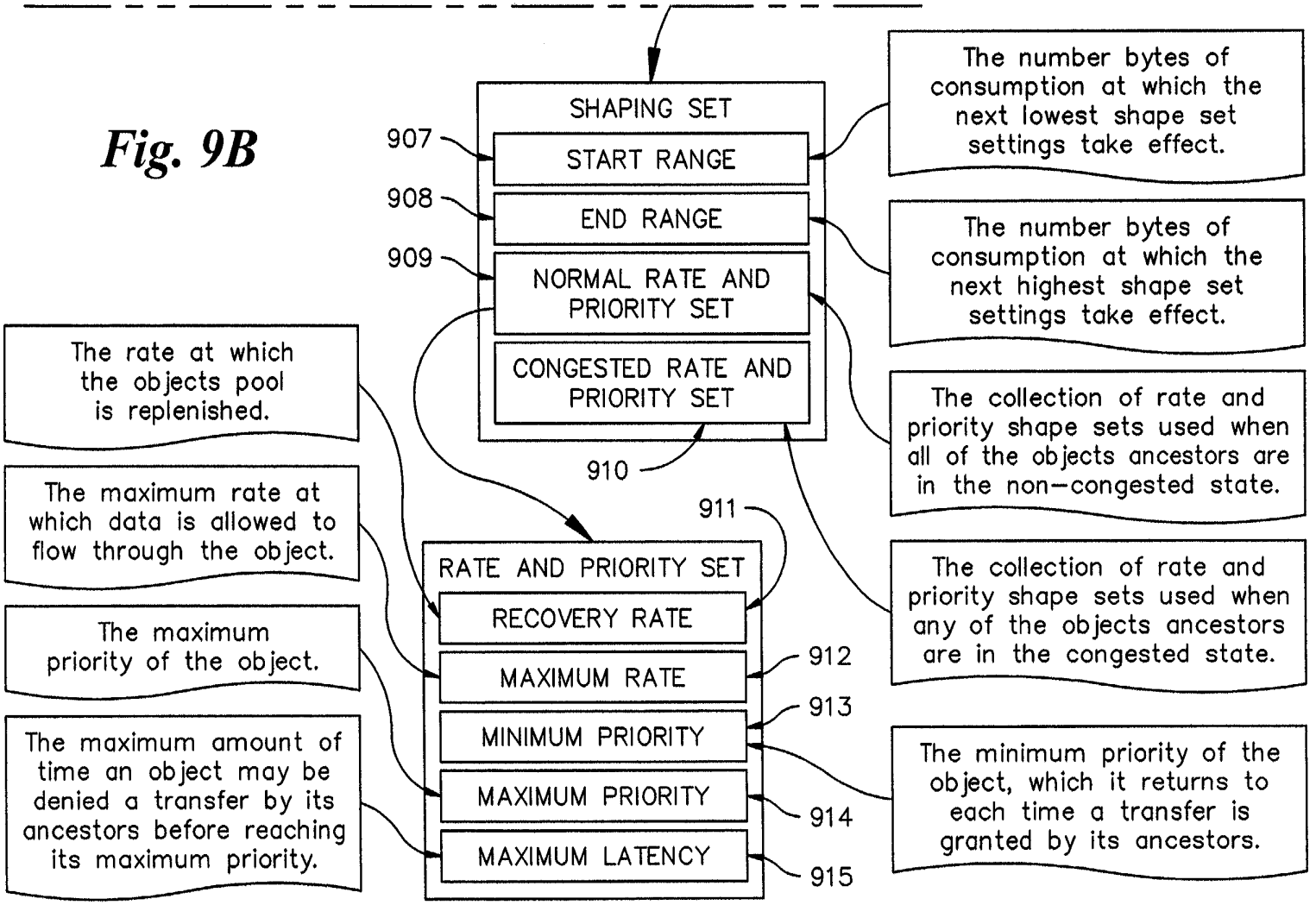
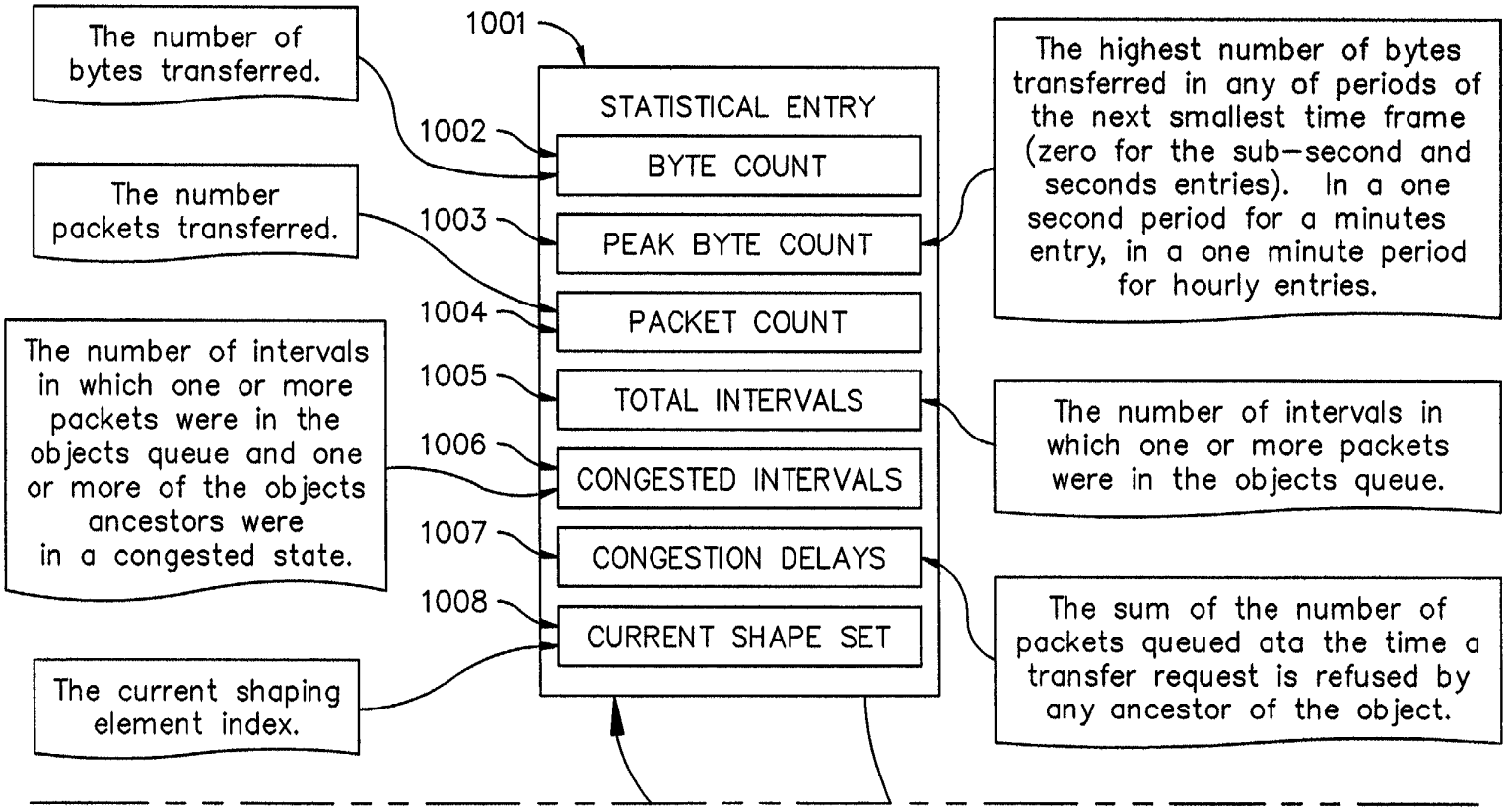

SHAPING SET
907
START RANGE
908
END RANGE
909
NORMAL RATE AND PRIORITY SET
CONGESTED RATE AND PRIORITY SET
910
911
RATE AND PRIORITY SET
RECOVERY RATE
MAXIMUM RATE
912
MINIMUM PRIORITY
913
MAXIMUM PRIORITY
914
MAXIMUM LATENCY
915
The number bytes of consumption at which the next lowest shape set settings take effect.
The number bytes of consumption at which the next highest shape set settings take effect.
The collection of rate and priority shape sets used when all of the objects ancestors are in the non-congested state.
The collection of rate and priority shape sets used when any of the objects ancestors are in the congested state.
The rate at which the objects pool is replenished.
The maximum rate at which data is allowed to flow through the object.
The maximum priority of the object.
The maximum amount of time an object may be denied a transfer by its ancestors before reaching its maximum priority.
The minimum priority of the object, which it returns to each time a transfer is granted by its ancestors.

Fig. 9B

Fig. 10A

FIG. 10A
FIG. 10B

Fig. 10



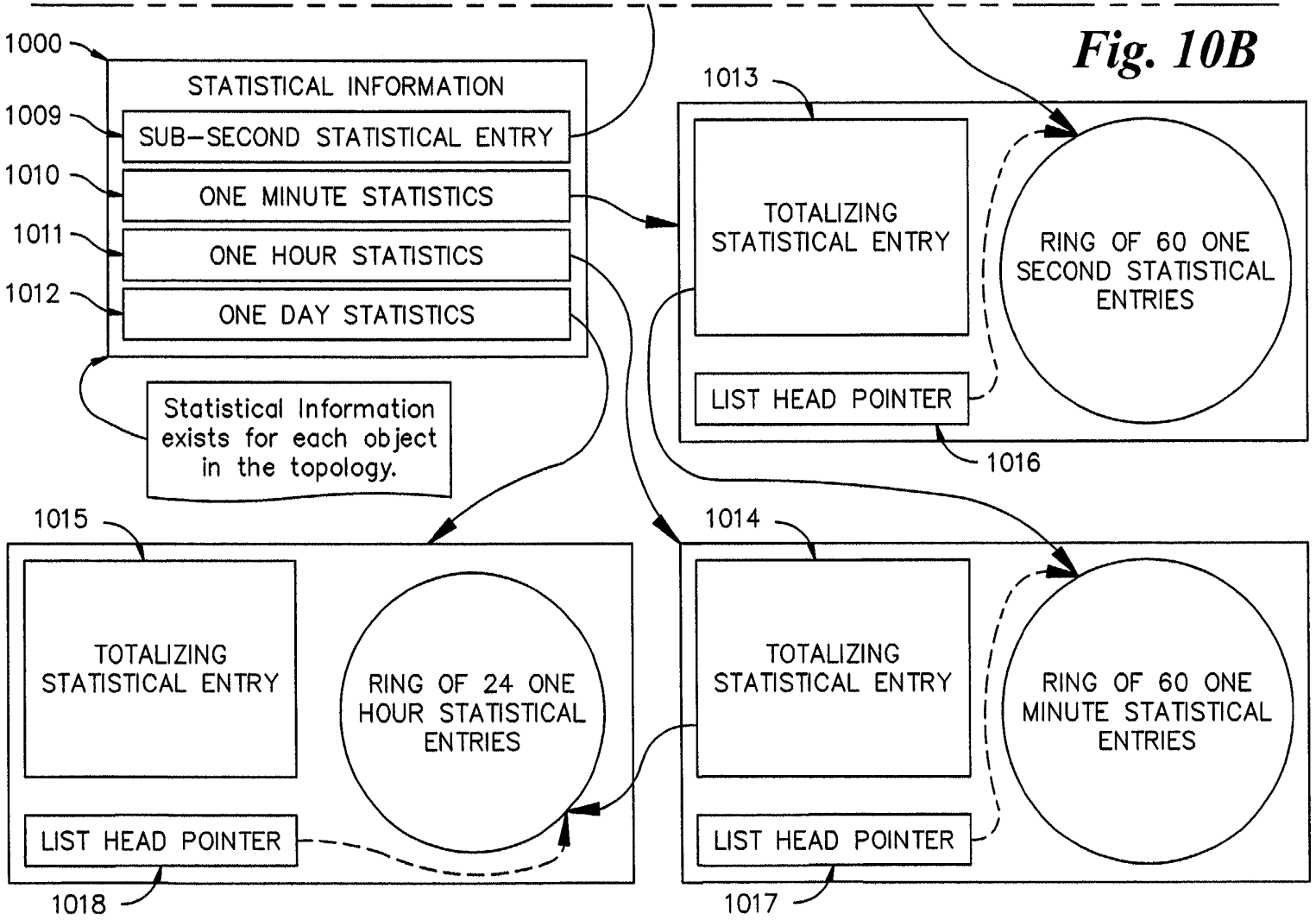

1000
STATISTICAL INFORMATION
1009
SUB-SECOND STATISTICAL ENTRY
1010
ONE MINUTE STATISTICS
1011
ONE HOUR STATISTICS
1012
ONE DAY STATISTICS
Statistical Information exists for each object in the topology.
1013
TOTALIZING STATISTICAL ENTRY
RING OF 60 ONE SECOND STATISTICAL ENTRIES
LIST HEAD POINTER
1016
1015
TOTALIZING STATISTICAL ENTRY
RING OF 24 ONE HOUR STATISTICAL ENTRIES
LIST HEAD POINTER
1018
1014
TOTALIZING STATISTICAL ENTRY
RING OF 60 ONE MINUTE STATISTICAL ENTRIES
LIST HEAD POINTER
1017

Fig. 10B

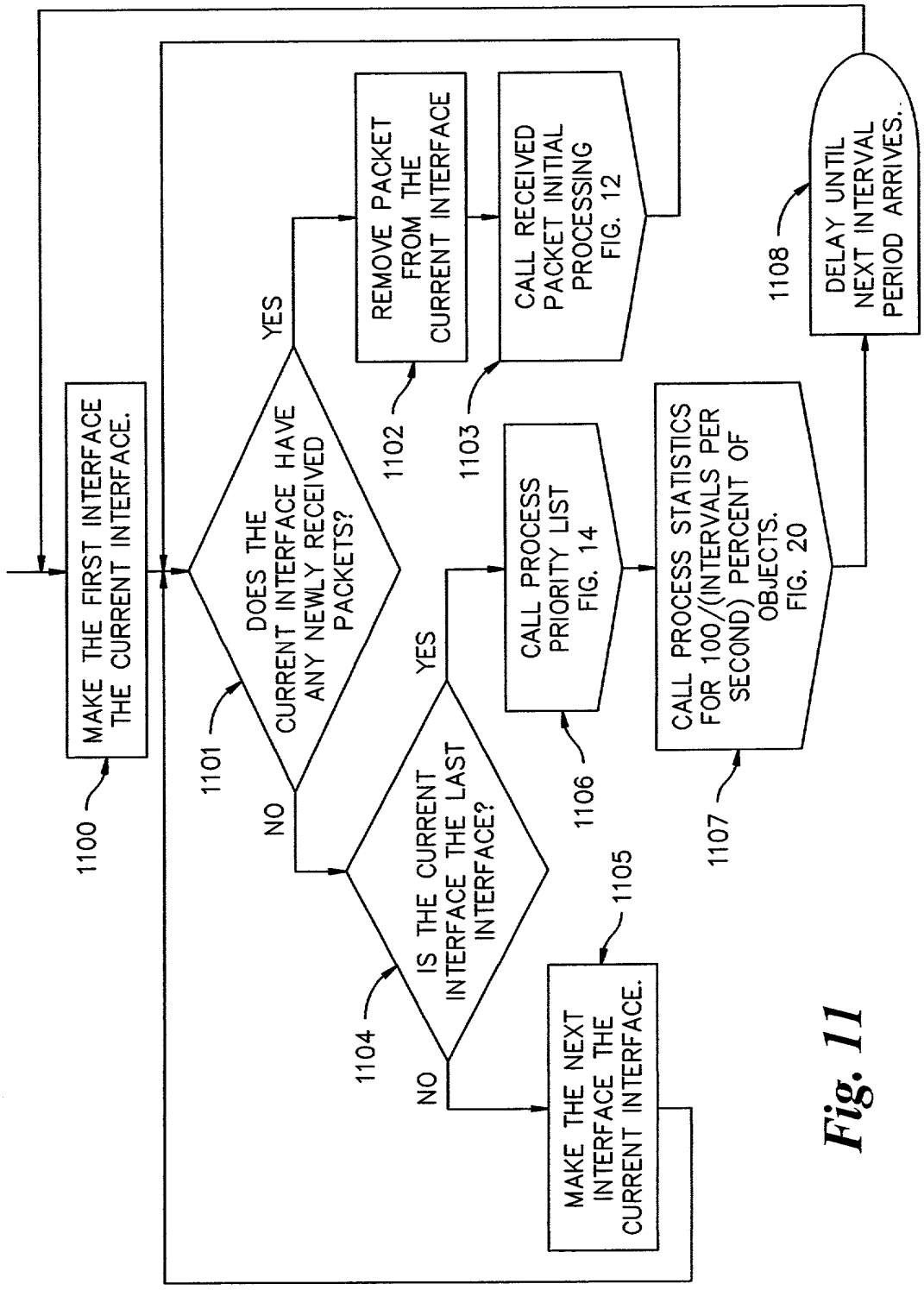

MAKE THE FIRST INTERFACE THE CURRENT INTERFACE.
1100
DOES THE CURRENT INTERFACE HAVE ANY NEWLY RECEIVED PACKETS?
1101
YES
NO
REMOVE PACKET FROM THE CURRENT INTERFACE
1102
CALL RECEIVED PACKET INITIAL PROCESSING FIG. 12
1103
IS THE CURRENT INTERFACE THE LAST INTERFACE?
1104
YES
NO
CALL PROCESS PRIORITY LIST FIG. 14
1106
MAKE THE NEXT INTERFACE THE CURRENT INTERFACE.
1105
CALL PROCESS STATISTICS FOR 100/(INTERVALS PER SECOND) PERCENT OF OBJECTS. FIG. 20
1107
DELAY UNTIL NEXT INTERVAL PERIOD ARRIVES.
1108

Fig. 11

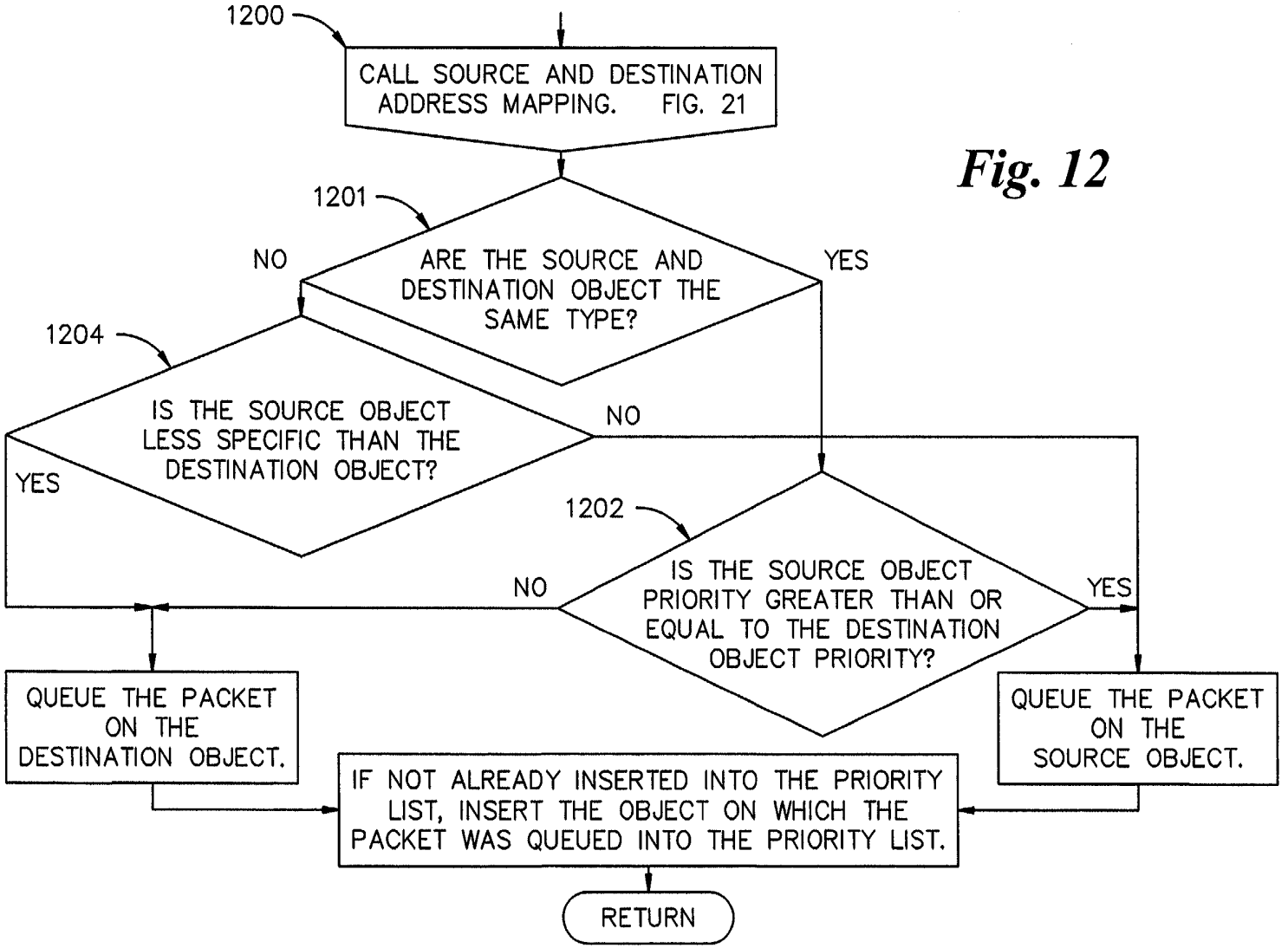
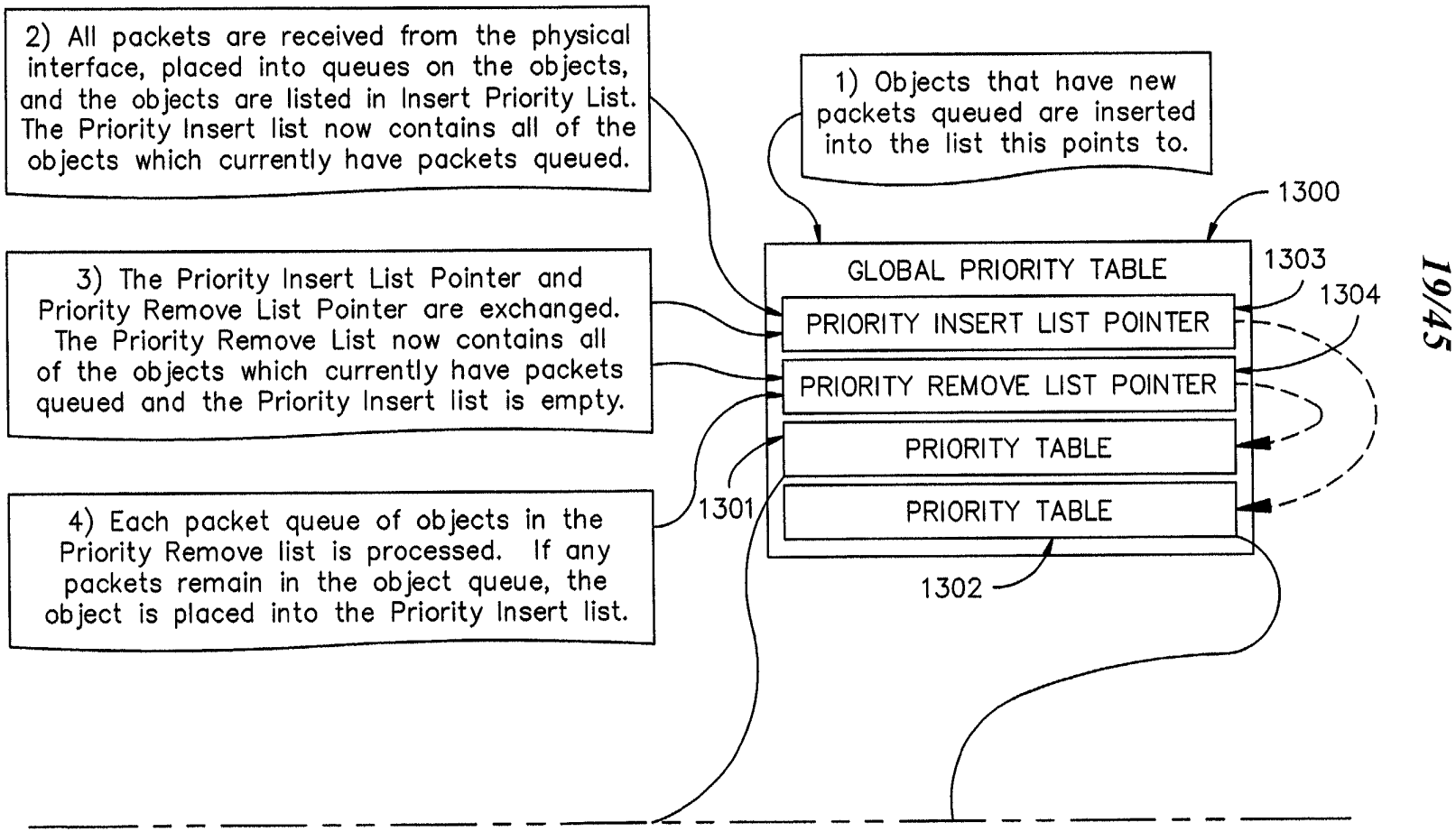

1200
CALL SOURCE AND DESTINATION ADDRESS MAPPING. FIG. 21
1201
ARE THE SOURCE AND DESTINATION OBJECT THE SAME TYPE?
NO
YES
1204
IS THE SOURCE OBJECT LESS SPECIFIC THAN THE DESTINATION OBJECT?
YES
NO
1202
IS THE SOURCE OBJECT PRIORITY GREATER THAN OR EQUAL TO THE DESTINATION OBJECT PRIORITY?
NO
YES
QUEUE THE PACKET ON THE DESTINATION OBJECT.
QUEUE THE PACKET ON THE SOURCE OBJECT.
IF NOT ALREADY INSERTED INTO THE PRIORITY LIST, INSERT THE OBJECT ON WHICH THE PACKET WAS QUEUED INTO THE PRIORITY LIST.
RETURN

Fig. 12

Fig. 13A

Fig. 13

FIG. 13A
FIG. 13B



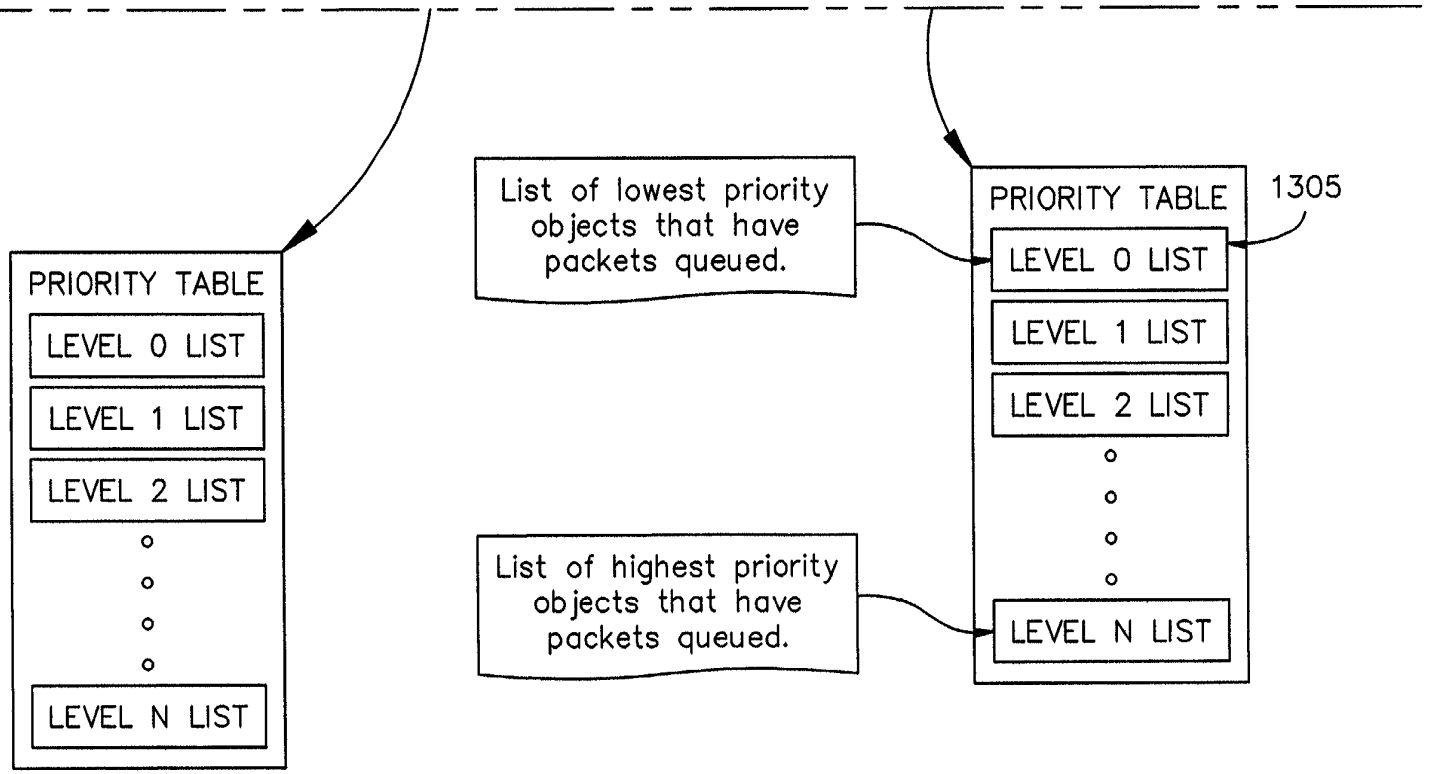

PRIORITY TABLE
LEVEL 0 LIST
LEVEL 1 LIST
LEVEL 2 LIST
LEVEL N LIST
List of lowest priority objects that have packets queued.
List of highest priority objects that have packets queued.
PRIORITY TABLE
1305
LEVEL 0 LIST
LEVEL 1 LIST
LEVEL 2 LIST
LEVEL N LIST

Fig. 13B

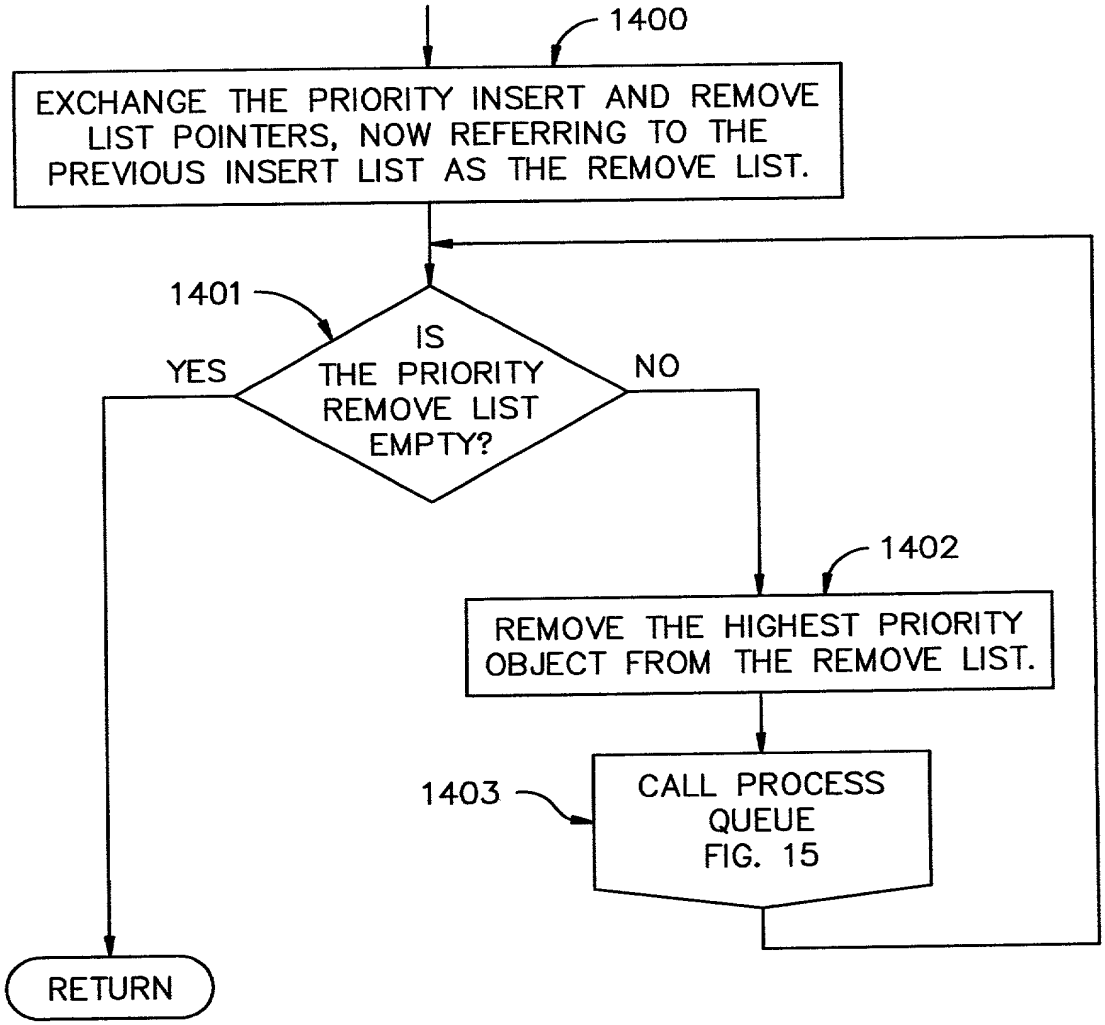

1400
EXCHANGE THE PRIORITY INSERT AND REMOVE LIST POINTERS, NOW REFERRING TO THE PREVIOUS INSERT LIST AS THE REMOVE LIST.
1401
IS THE PRIORITY REMOVE LIST EMPTY?
YES
NO
1402
REMOVE THE HIGHEST PRIORITY OBJECT FROM THE REMOVE LIST.
1403
CALL PROCESS QUEUE FIG. 15
RETURN

Fig. 14

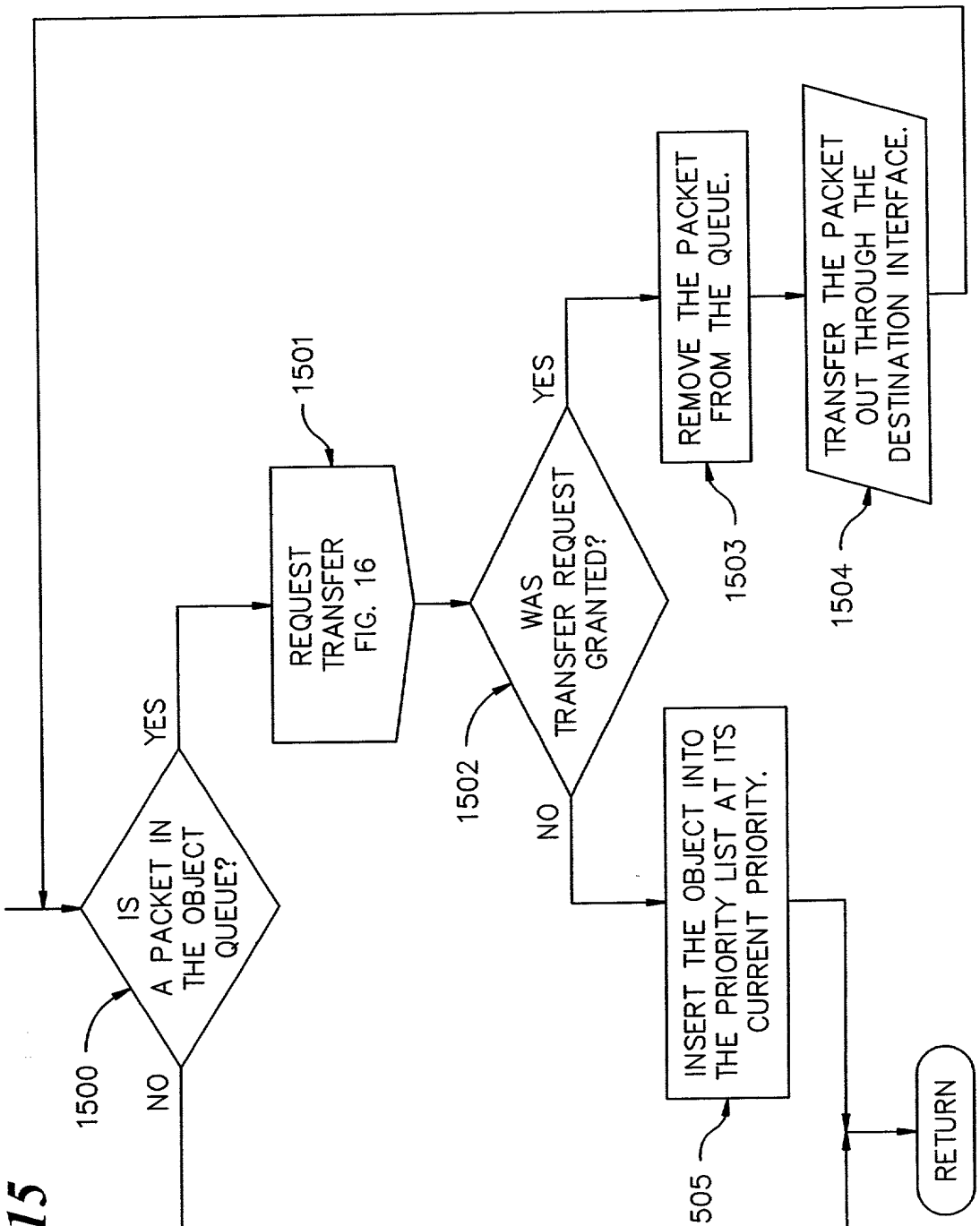

IS A PACKET IN THE OBJECT QUEUE?
1500
YES
NO
REQUEST TRANSFER FIG. 16
1501
WAS TRANSFER REQUEST GRANTED?
1502
YES
NO
REMOVE THE PACKET FROM THE QUEUE.
1503
TRANSFER THE PACKET OUT THROUGH THE DESTINATION INTERFACE.
1504
INSERT THE OBJECT INTO THE PRIORITY LIST AT ITS CURRENT PRIORITY.
1505
RETURN

Fig. 15

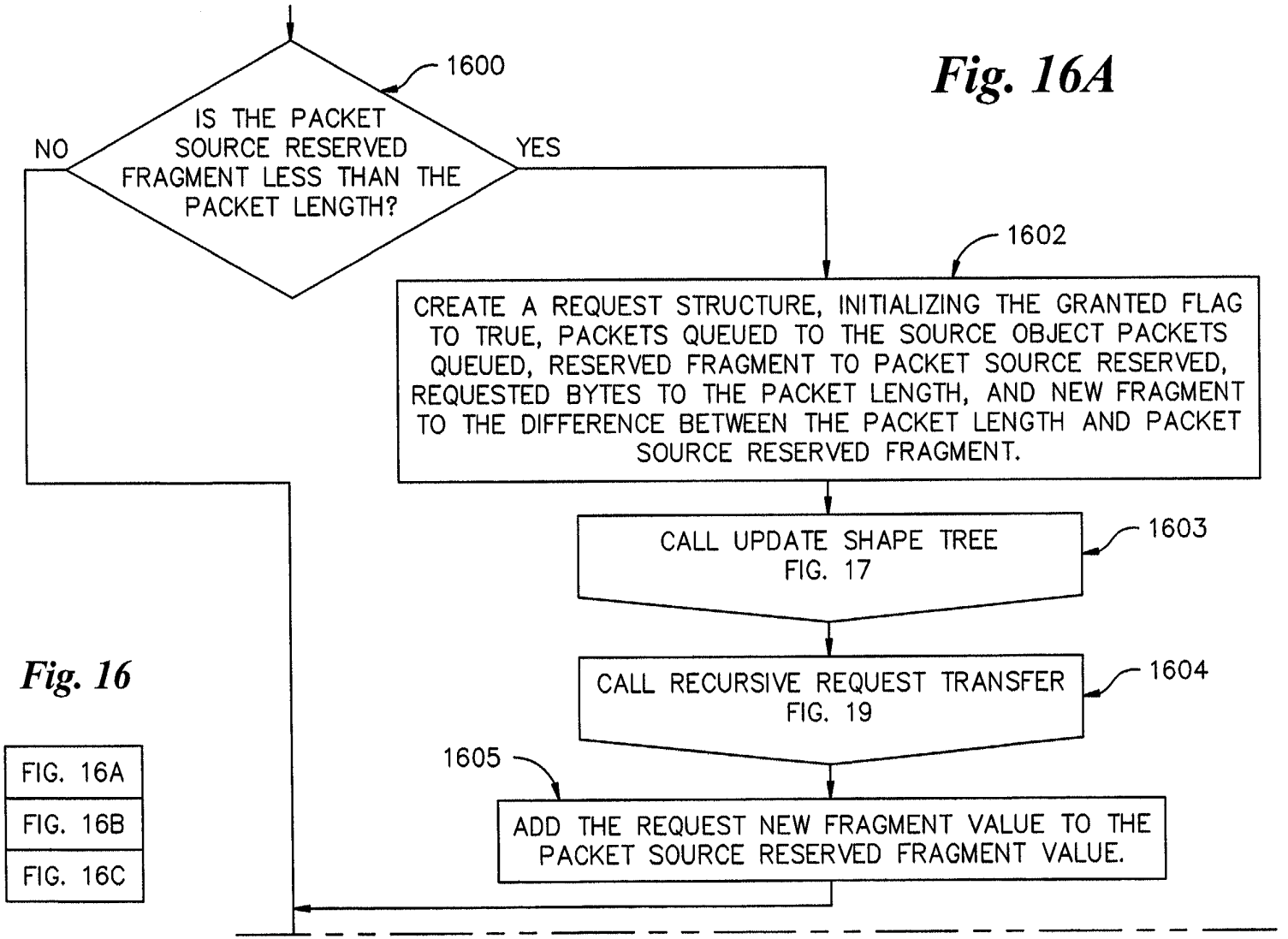


Fig. 16A

Fig. 16

FIG. 16A
FIG. 16B
FIG. 16C

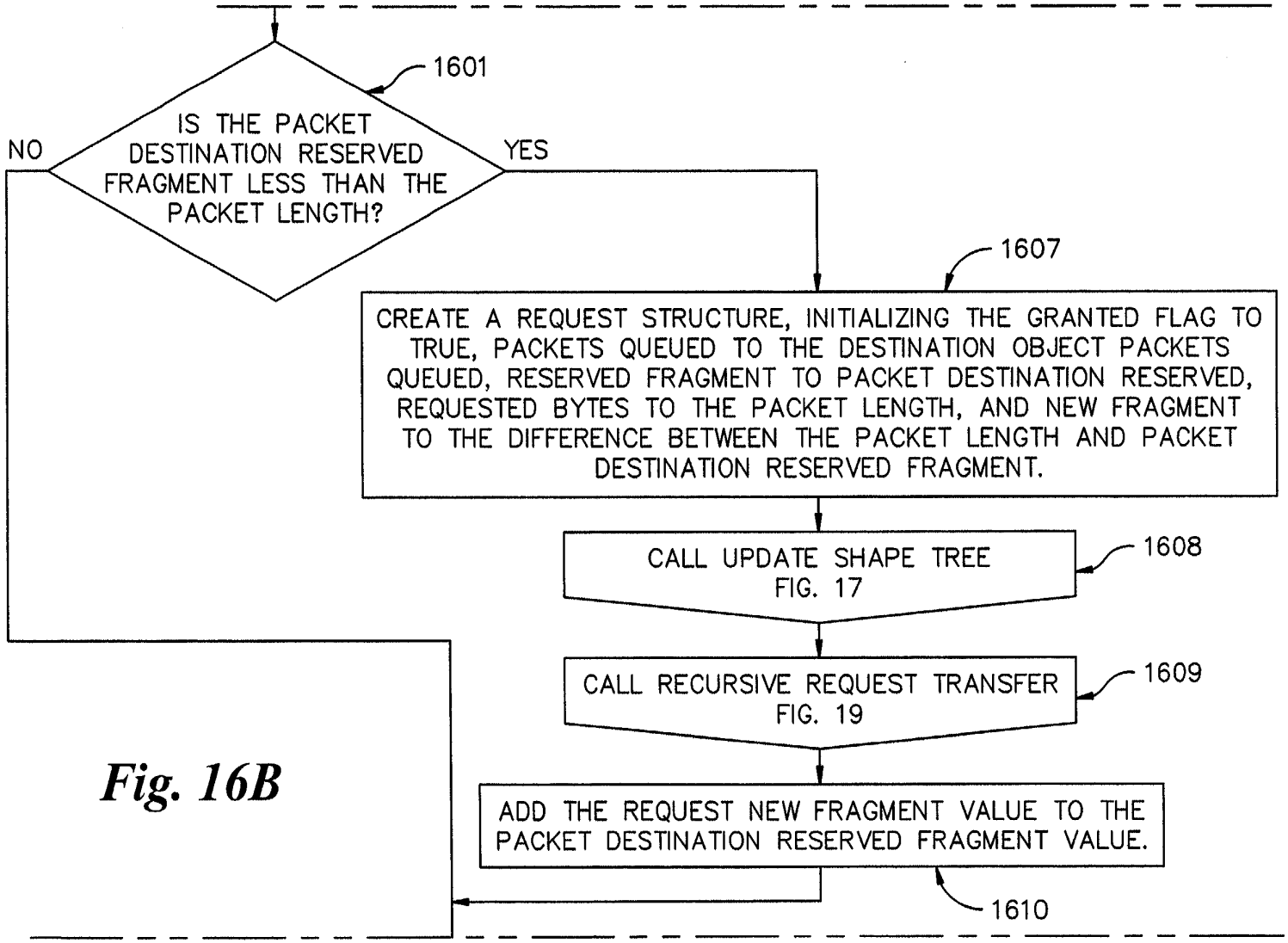

1601
IS THE PACKET DESTINATION RESERVED FRAGMENT LESS THAN THE PACKET LENGTH?
NO
YES
1607
CREATE A REQUEST STRUCTURE, INITIALIZING THE GRANTED FLAG TO TRUE, PACKETS QUEUED TO THE DESTINATION OBJECT PACKETS QUEUED, RESERVED FRAGMENT TO PACKET DESTINATION RESERVED, REQUESTED BYTES TO THE PACKET LENGTH, AND NEW FRAGMENT TO THE DIFFERENCE BETWEEN THE PACKET LENGTH AND PACKET DESTINATION RESERVED FRAGMENT.
CALL UPDATE SHAPE TREE FIG. 17
1608
CALL RECURSIVE REQUEST TRANSFER FIG. 19
1609
ADD THE REQUEST NEW FRAGMENT VALUE TO THE PACKET DESTINATION RESERVED FRAGMENT VALUE.
1610

Fig. 16B

Fig. 16C

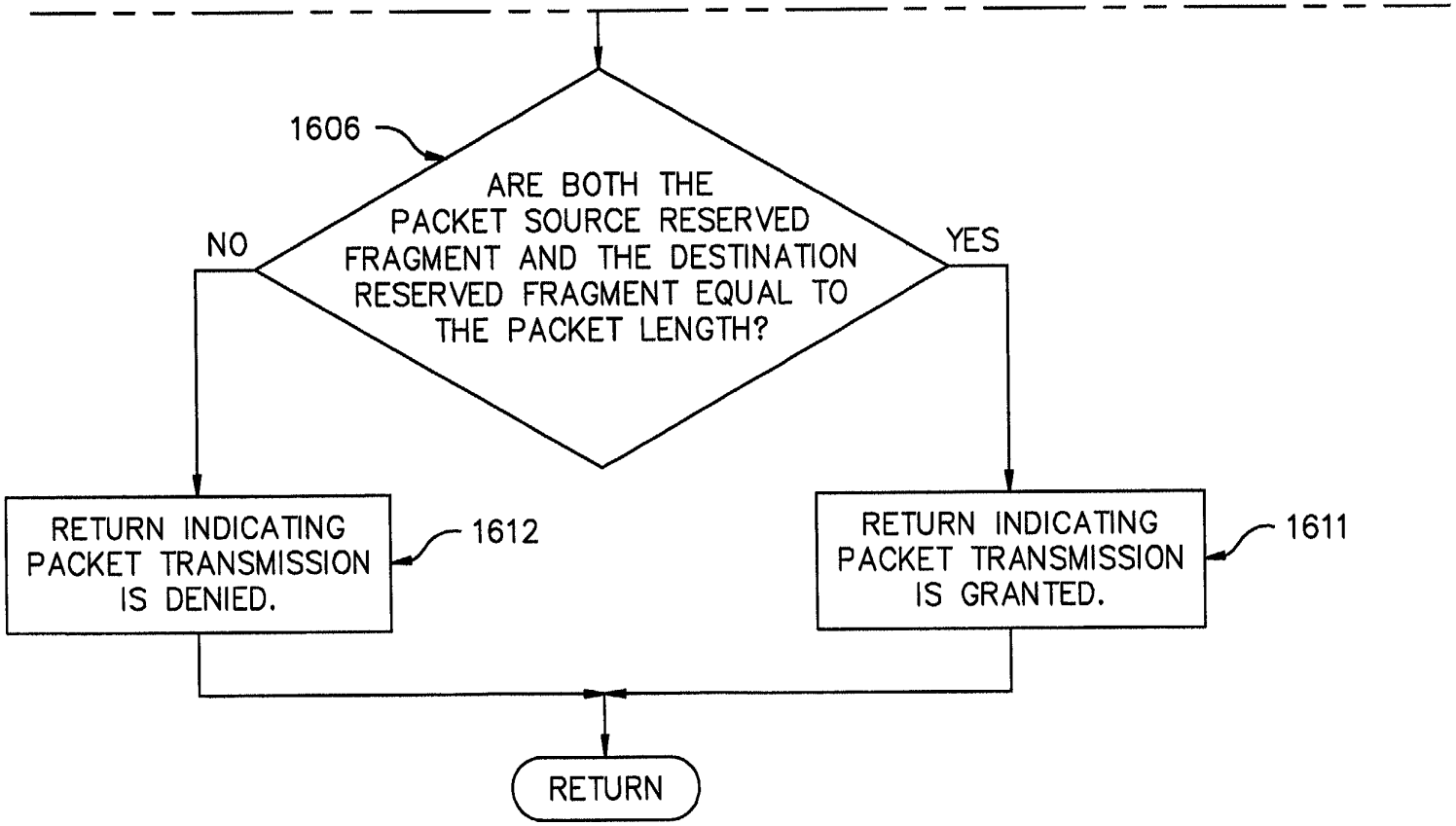
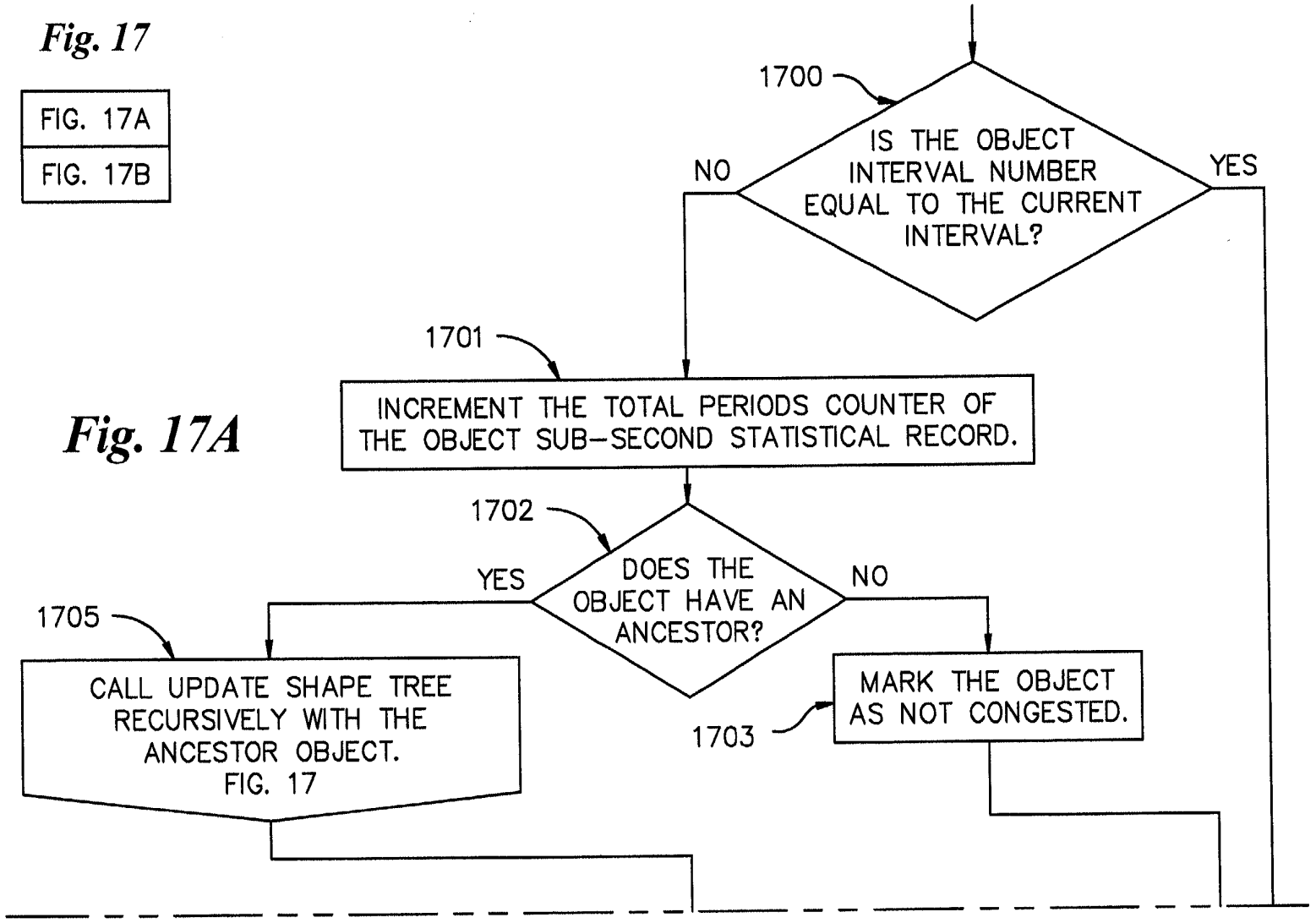

1606
ARE BOTH THE PACKET SOURCE RESERVED FRAGMENT AND THE DESTINATION RESERVED FRAGMENT EQUAL TO THE PACKET LENGTH?
NO
YES
RETURN INDICATING PACKET TRANSMISSION IS DENIED.
1612
RETURN INDICATING PACKET TRANSMISSION IS GRANTED.
1611
RETURN

Fig. 17

FIG. 17A
FIG. 17B

Fig. 17A



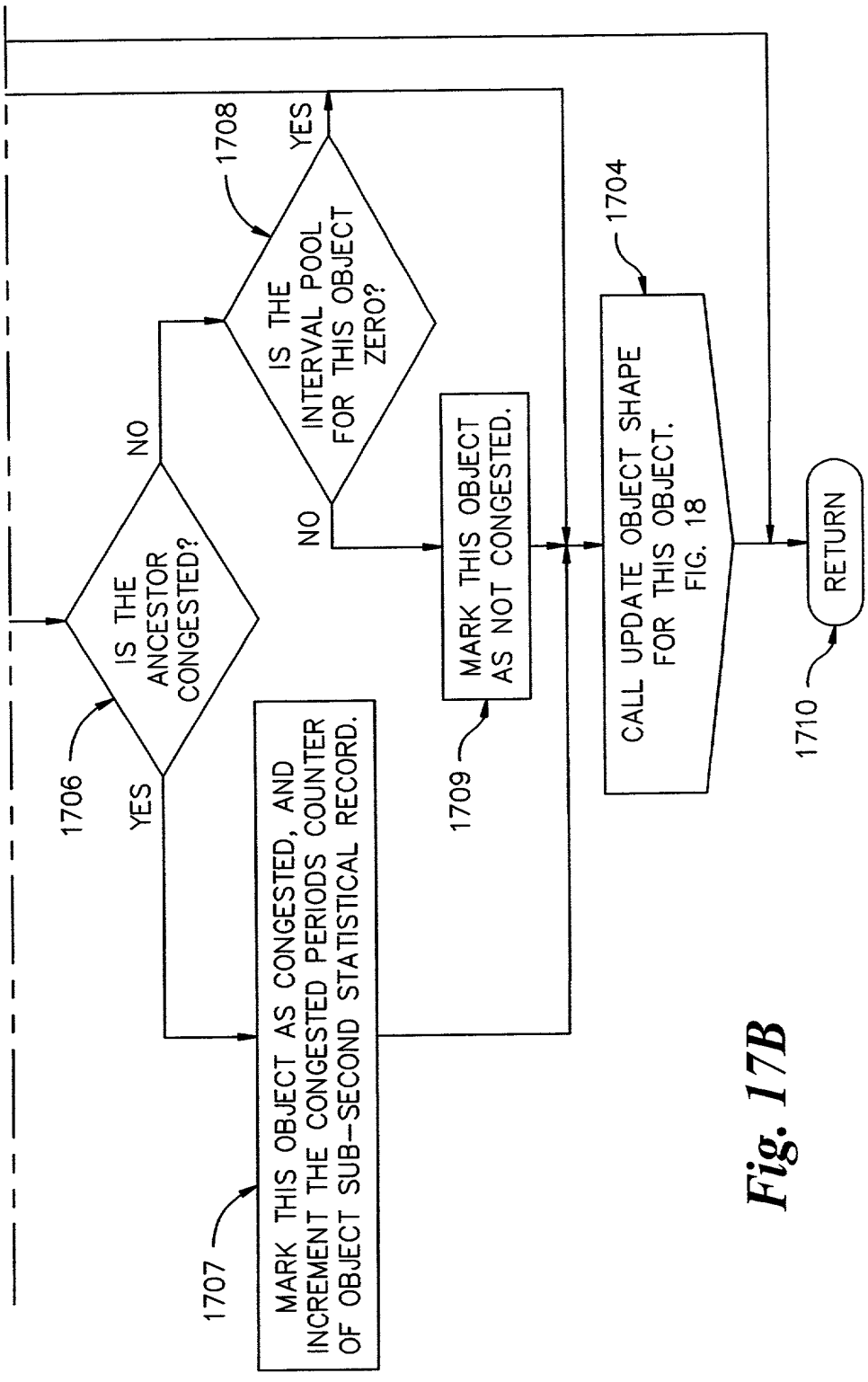

IS THE ANCESTOR CONGESTED?
1706
YES
NO
IS THE INTERVAL POOL FOR THIS OBJECT ZERO?
1708
YES
NO
MARK THIS OBJECT AS CONGESTED, AND INCREMENT THE CONGESTED PERIODS COUNTER OF OBJECT SUB-SECOND STATISTICAL RECORD.
1707
MARK THIS OBJECT AS NOT CONGESTED.
1709
CALL UPDATE OBJECT SHAPE FOR THIS OBJECT. FIG. 18
1704
RETURN
1710

Fig. 17B

Fig. 18

FIG. 18A
FIG. 18B

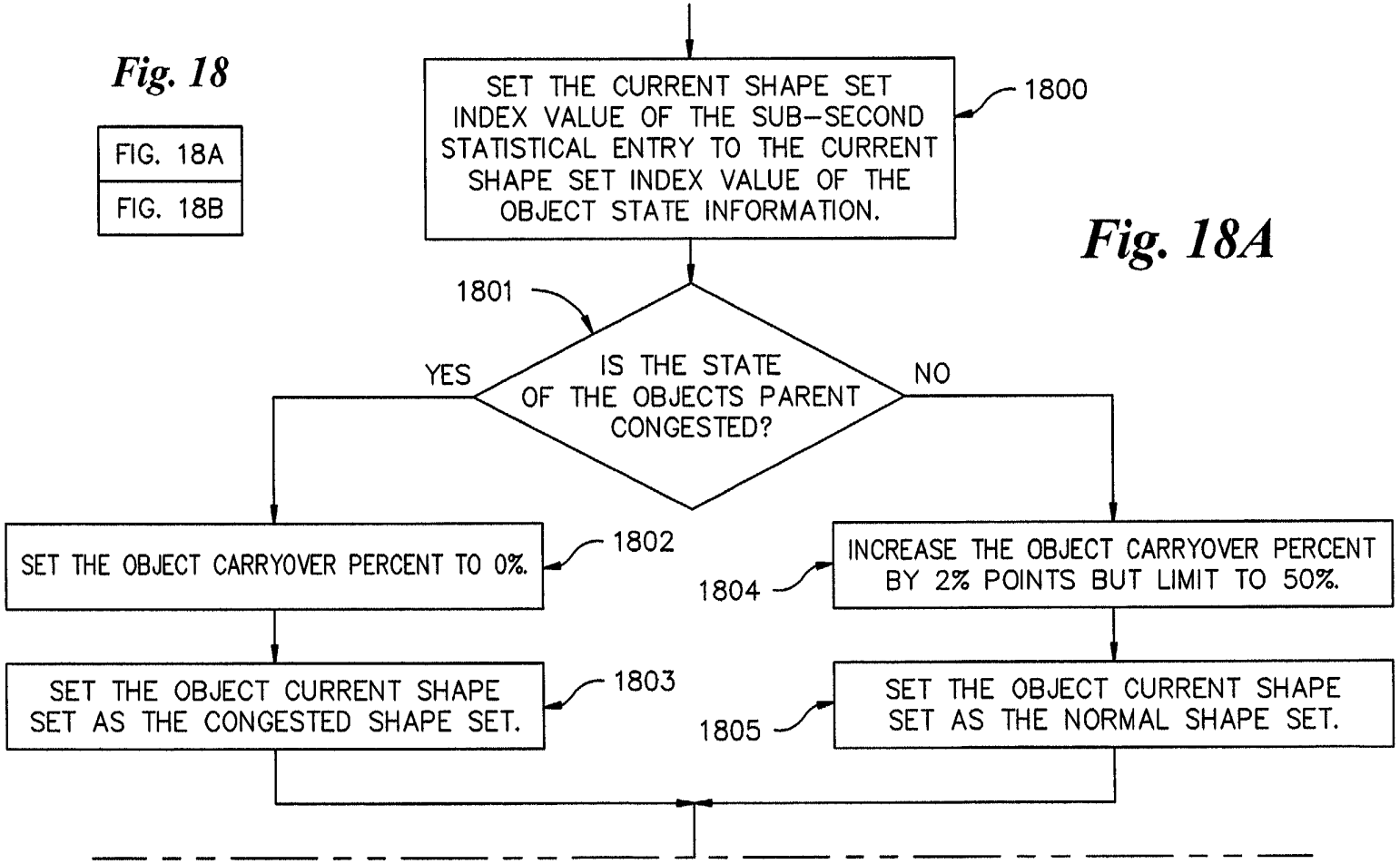


Fig. 18A

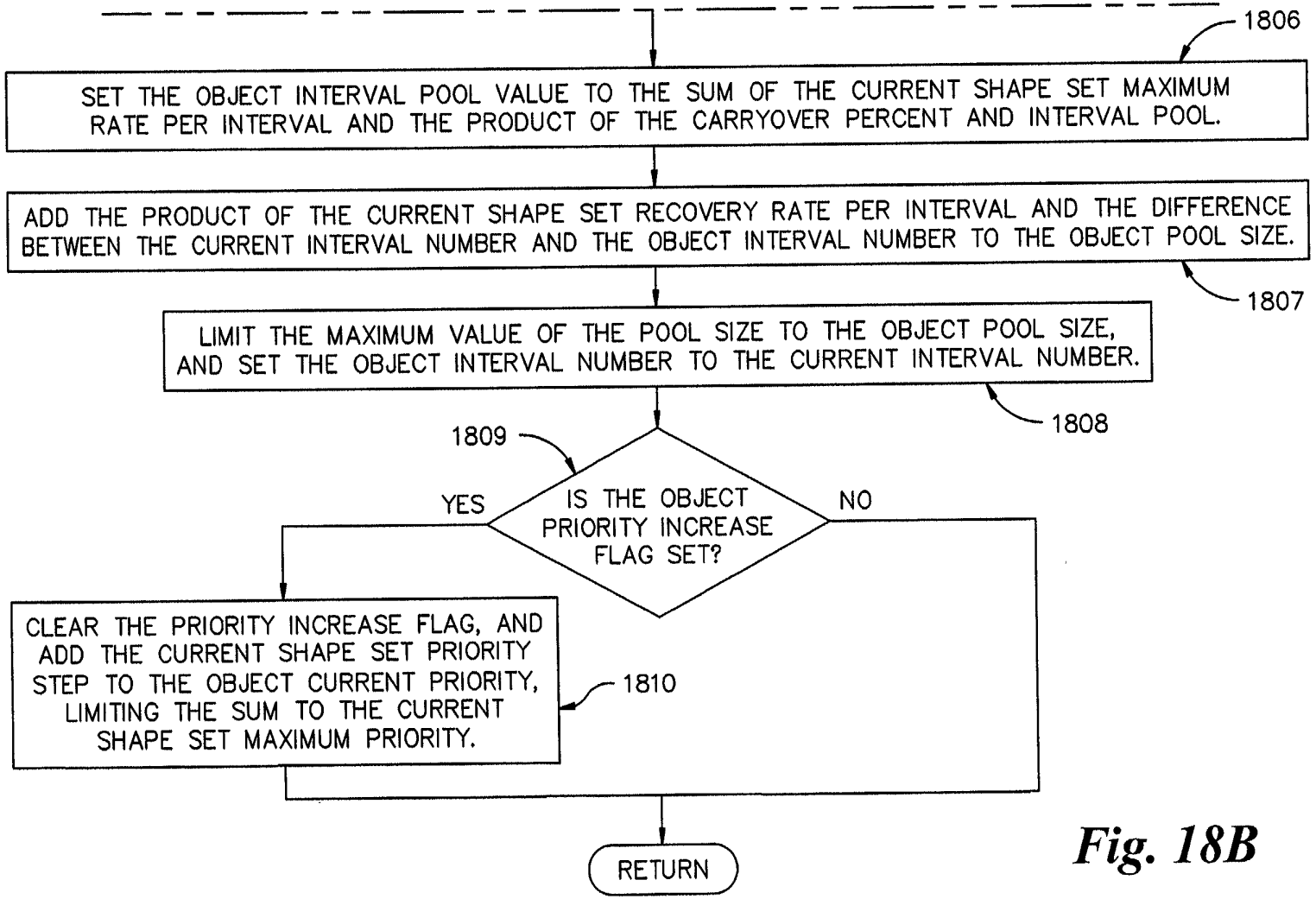

1806
SET THE OBJECT INTERVAL POOL VALUE TO THE SUM OF THE CURRENT SHAPE SET MAXIMUM RATE PER INTERVAL AND THE PRODUCT OF THE CARRYOVER PERCENT AND INTERVAL POOL.
ADD THE PRODUCT OF THE CURRENT SHAPE SET RECOVERY RATE PER INTERVAL AND THE DIFFERENCE BETWEEN THE CURRENT INTERVAL NUMBER AND THE OBJECT INTERVAL NUMBER TO THE OBJECT POOL SIZE.
1807
LIMIT THE MAXIMUM VALUE OF THE POOL SIZE TO THE OBJECT POOL SIZE, AND SET THE OBJECT INTERVAL NUMBER TO THE CURRENT INTERVAL NUMBER.
1808
1809
IS THE OBJECT PRIORITY INCREASE FLAG SET?
YES
NO
CLEAR THE PRIORITY INCREASE FLAG, AND ADD THE CURRENT SHAPE SET PRIORITY STEP TO THE OBJECT CURRENT PRIORITY, LIMITING THE SUM TO THE CURRENT SHAPE SET MAXIMUM PRIORITY.
1810
RETURN

Fig. 18B

Fig. 19

FIG. 19A
FIG. 19B
FIG. 19C

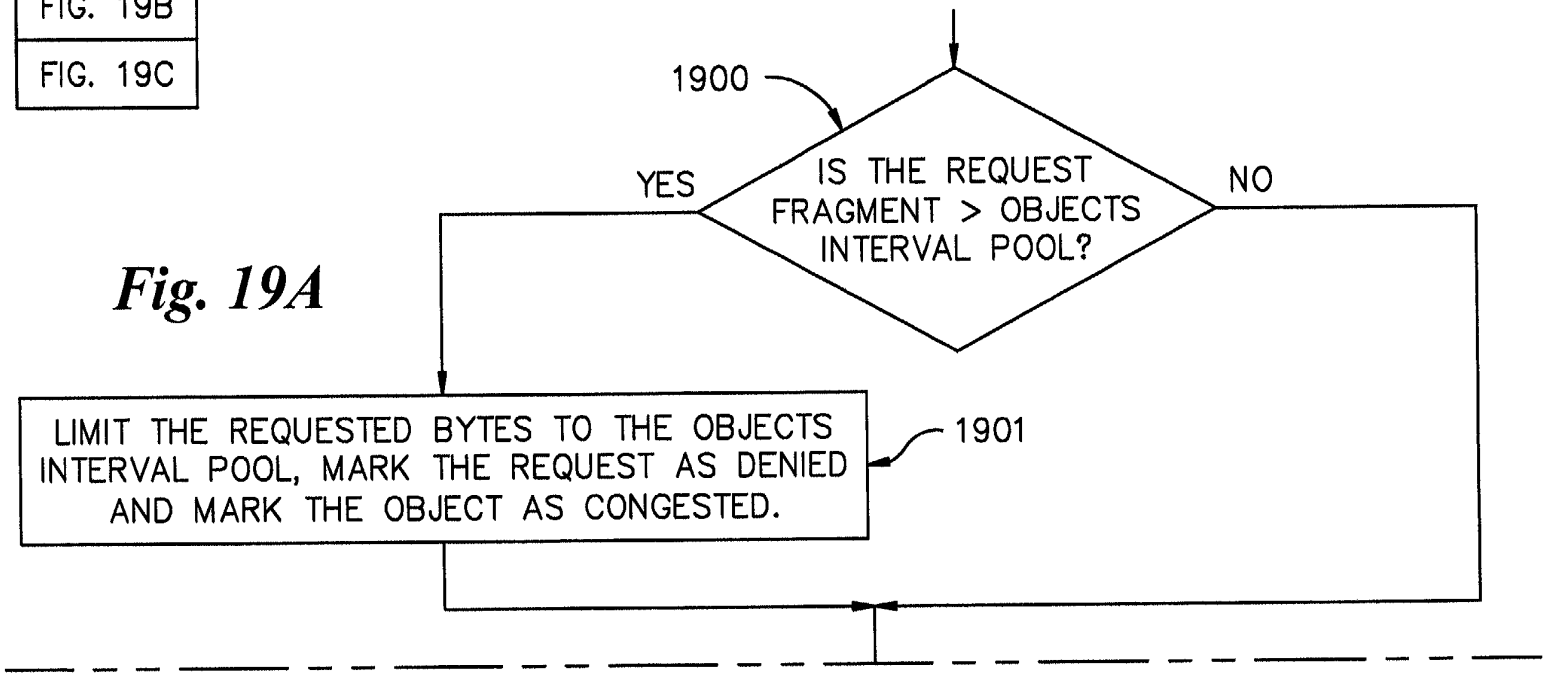
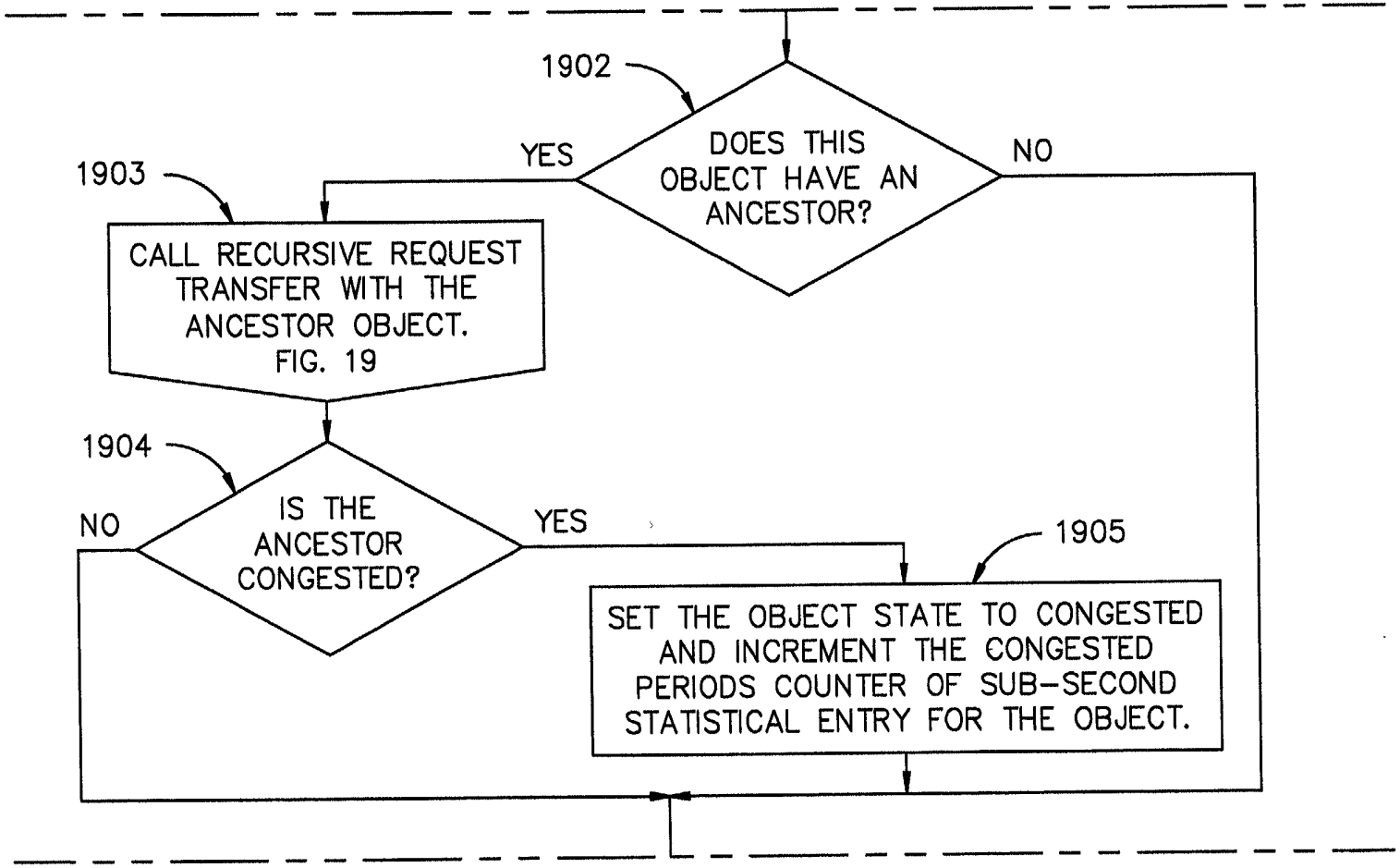


Fig. 19A

Fig. 19B


1902
DOES THIS OBJECT HAVE AN ANCESTOR?
YES
NO
1903
CALL RECURSIVE REQUEST TRANSFER WITH THE ANCESTOR OBJECT. FIG. 19
1904
IS THE ANCESTOR CONGESTED?
NO
YES
1905
SET THE OBJECT STATE TO CONGESTED AND INCREMENT THE CONGESTED PERIODS COUNTER OF SUB-SECOND STATISTICAL ENTRY FOR THE OBJECT.

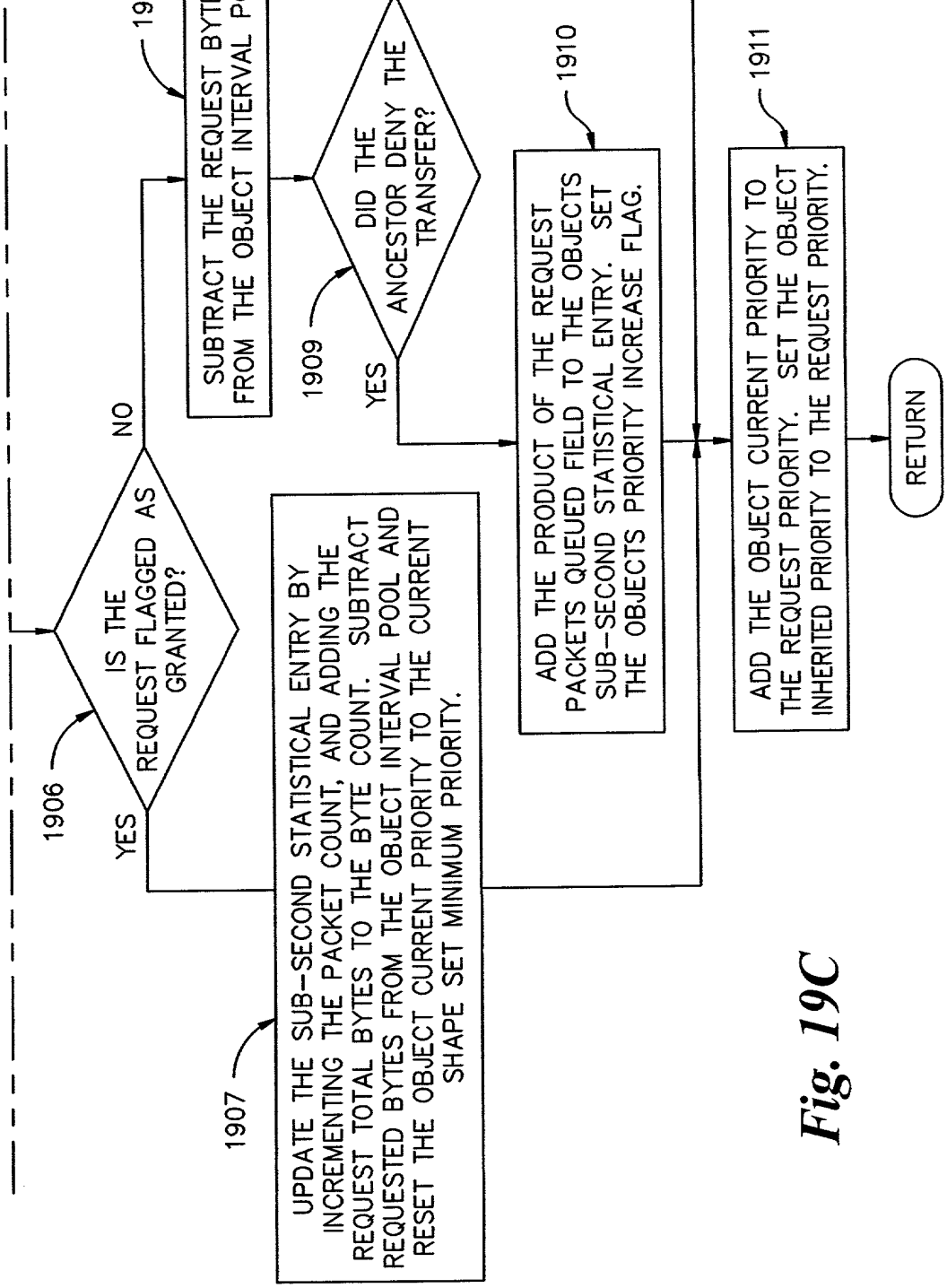

1906
IS THE REQUEST FLAGGED AS GRANTED?
YES
NO
1907
UPDATE THE SUB-SECOND STATISTICAL ENTRY BY INCREMENTING THE PACKET COUNT, AND ADDING THE REQUEST TOTAL BYTES TO THE BYTE COUNT. SUBTRACT REQUESTED BYTES FROM THE OBJECT INTERVAL POOL AND RESET THE OBJECT CURRENT PRIORITY TO THE CURRENT SHAPE SET MINIMUM PRIORITY.
1908
SUBTRACT THE REQUEST BYTES FROM THE OBJECT INTERVAL POOL
1909
DID THE ANCESTOR DENY THE TRANSFER?
YES
NO
1910
ADD THE PRODUCT OF THE REQUEST PACKETS QUEUED FIELD TO THE OBJECTS SUB-SECOND STATISTICAL ENTRY. SET THE OBJECTS PRIORITY INCREASE FLAG.
1911
ADD THE OBJECT CURRENT PRIORITY TO THE REQUEST PRIORITY. SET THE OBJECT INHERITED PRIORITY TO THE REQUEST PRIORITY.
RETURN

Fig. 19C

Fig. 20

FIG. 20A
FIG. 20B
FIG. 20C

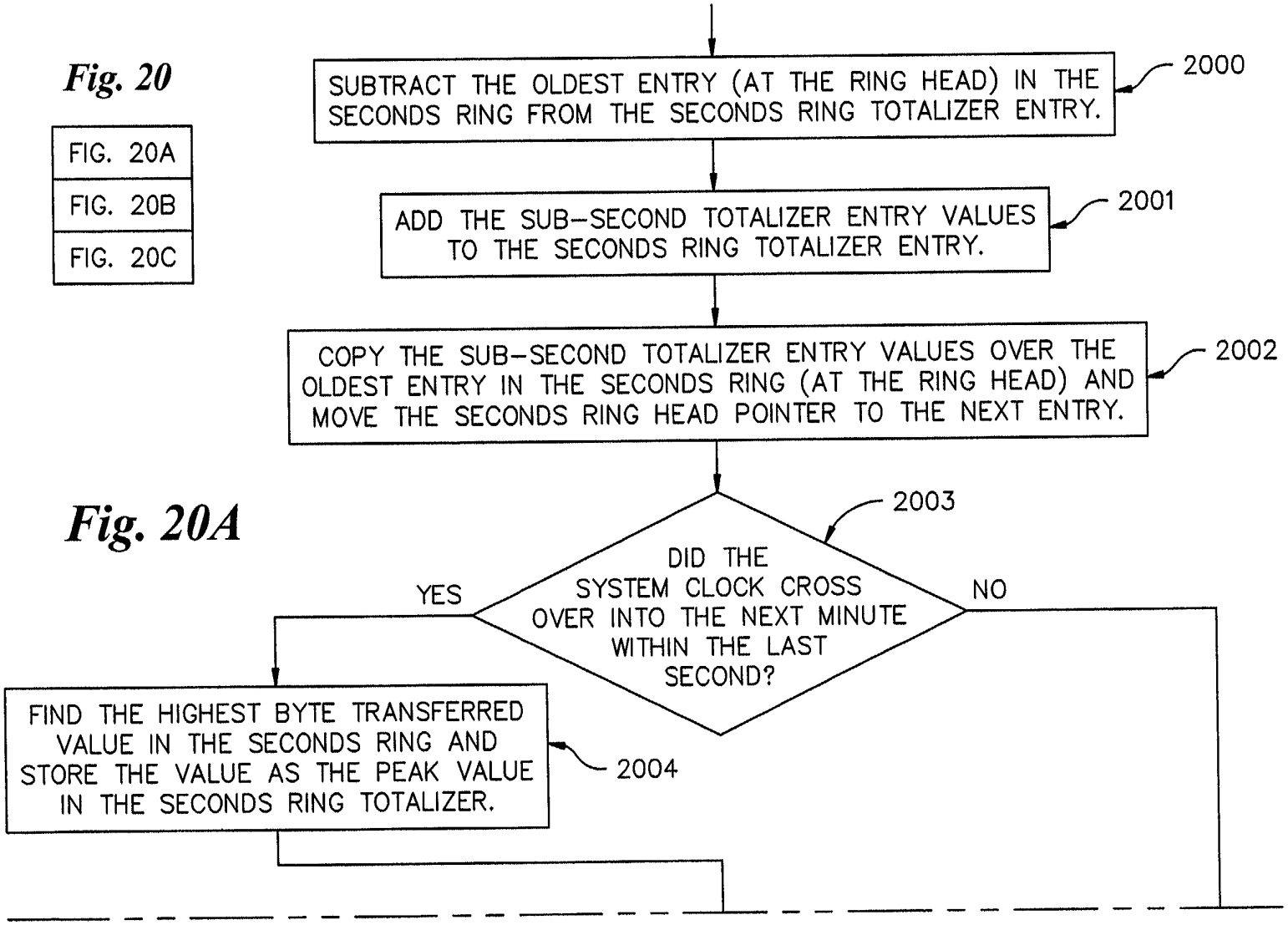


Fig. 20A

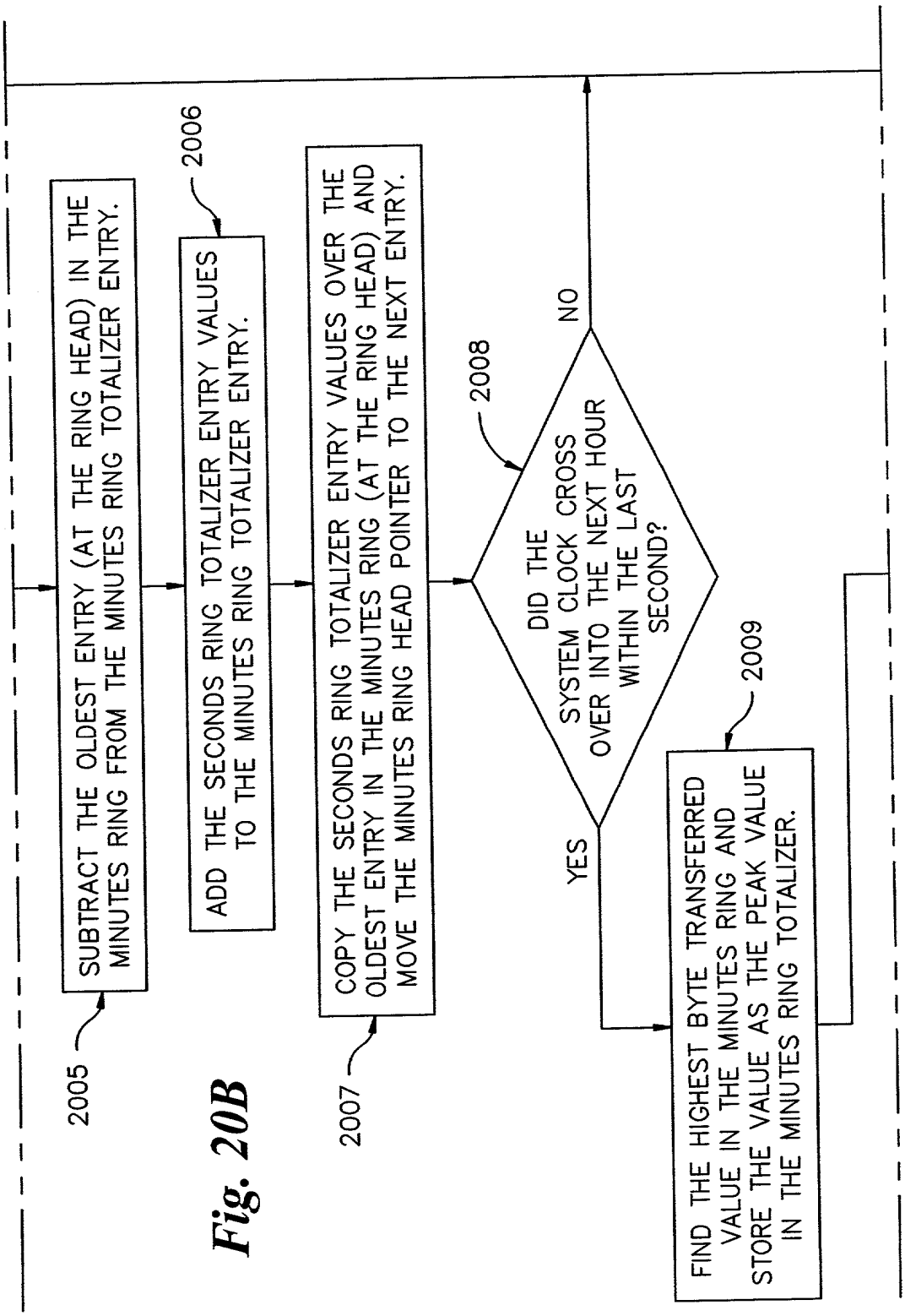

SUBTRACT THE OLDEST ENTRY (AT THE RING HEAD) IN THE MINUTES RING FROM THE MINUTES RING TOTALIZER ENTRY.
2005
ADD THE SECONDS RING TOTALIZER ENTRY VALUES TO THE MINUTES RING TOTALIZER ENTRY.
2006
COPY THE SECONDS RING TOTALIZER ENTRY VALUES OVER THE OLDEST ENTRY IN THE MINUTES RING (AT THE RING HEAD) AND MOVE THE MINUTES RING HEAD POINTER TO THE NEXT ENTRY.
2007
DID THE SYSTEM CLOCK CROSS OVER INTO THE NEXT HOUR WITHIN THE LAST SECOND?
2008
YES
NO
FIND THE HIGHEST BYTE TRANSFERRED VALUE IN THE MINUTES RING AND STORE THE VALUE AS THE PEAK VALUE IN THE MINUTES RING TOTALIZER.
2009

Fig. 20B

Fig. 20C

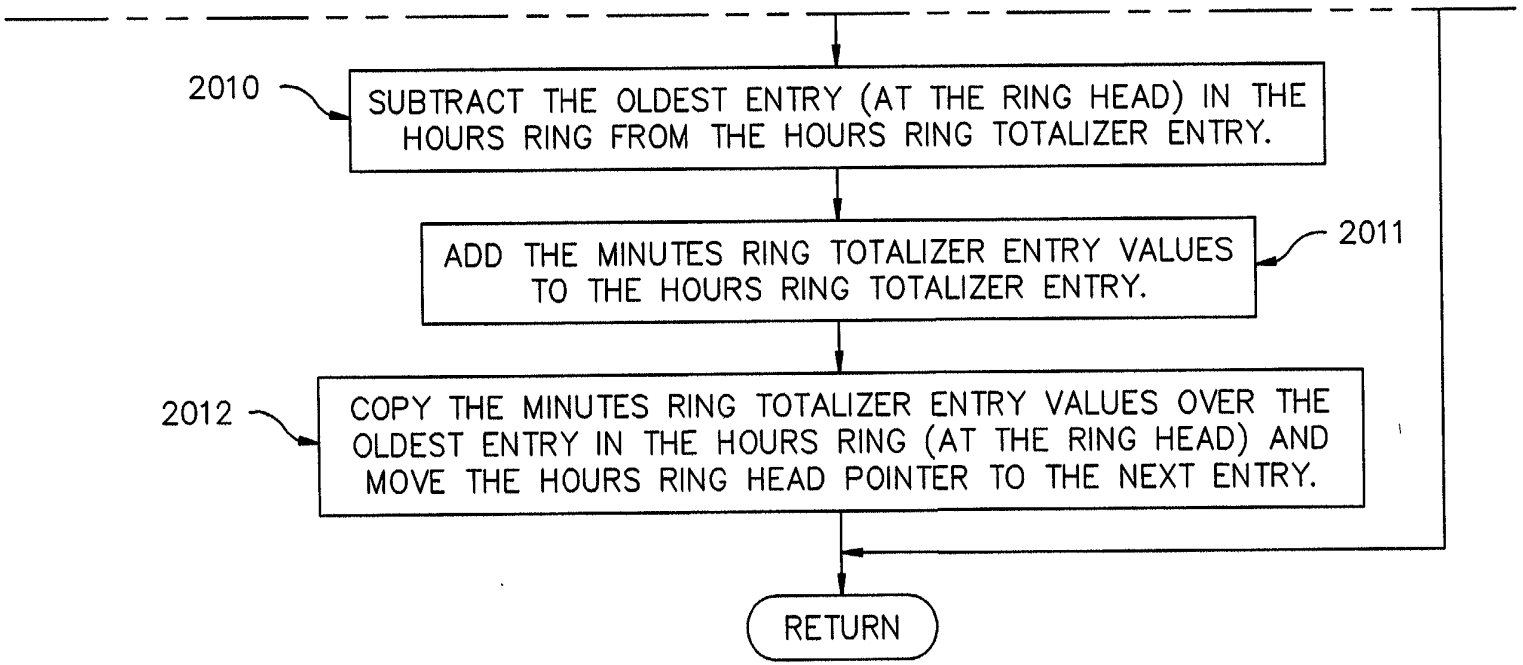
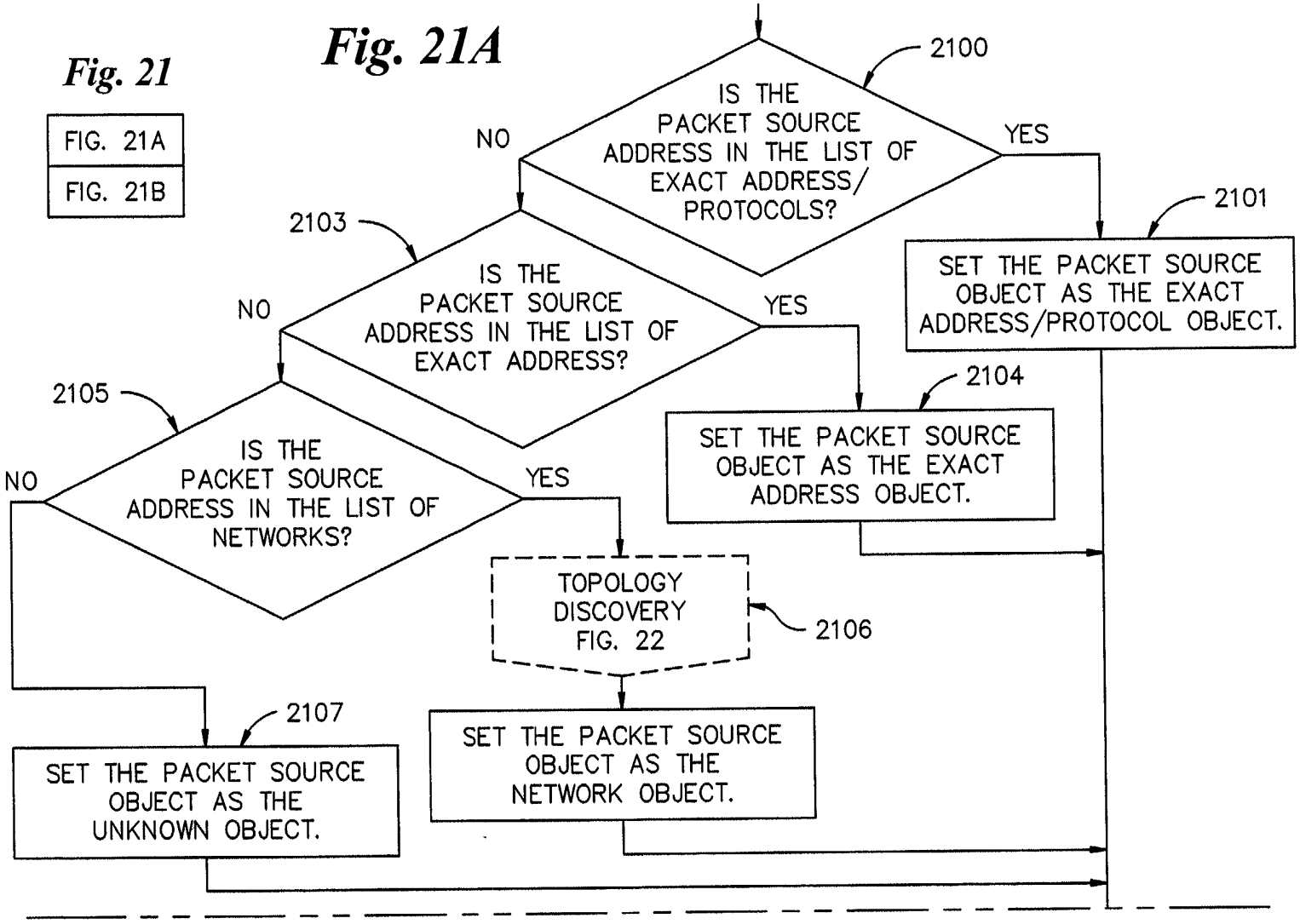

2010
SUBTRACT THE OLDEST ENTRY (AT THE RING HEAD) IN THE HOURS RING FROM THE HOURS RING TOTALIZER ENTRY.
ADD THE MINUTES RING TOTALIZER ENTRY VALUES TO THE HOURS RING TOTALIZER ENTRY.
2011
2012
COPY THE MINUTES RING TOTALIZER ENTRY VALUES OVER THE OLDEST ENTRY IN THE HOURS RING (AT THE RING HEAD) AND MOVE THE HOURS RING HEAD POINTER TO THE NEXT ENTRY.
RETURN

Fig. 21

FIG. 21A
FIG. 21B

Fig. 21A



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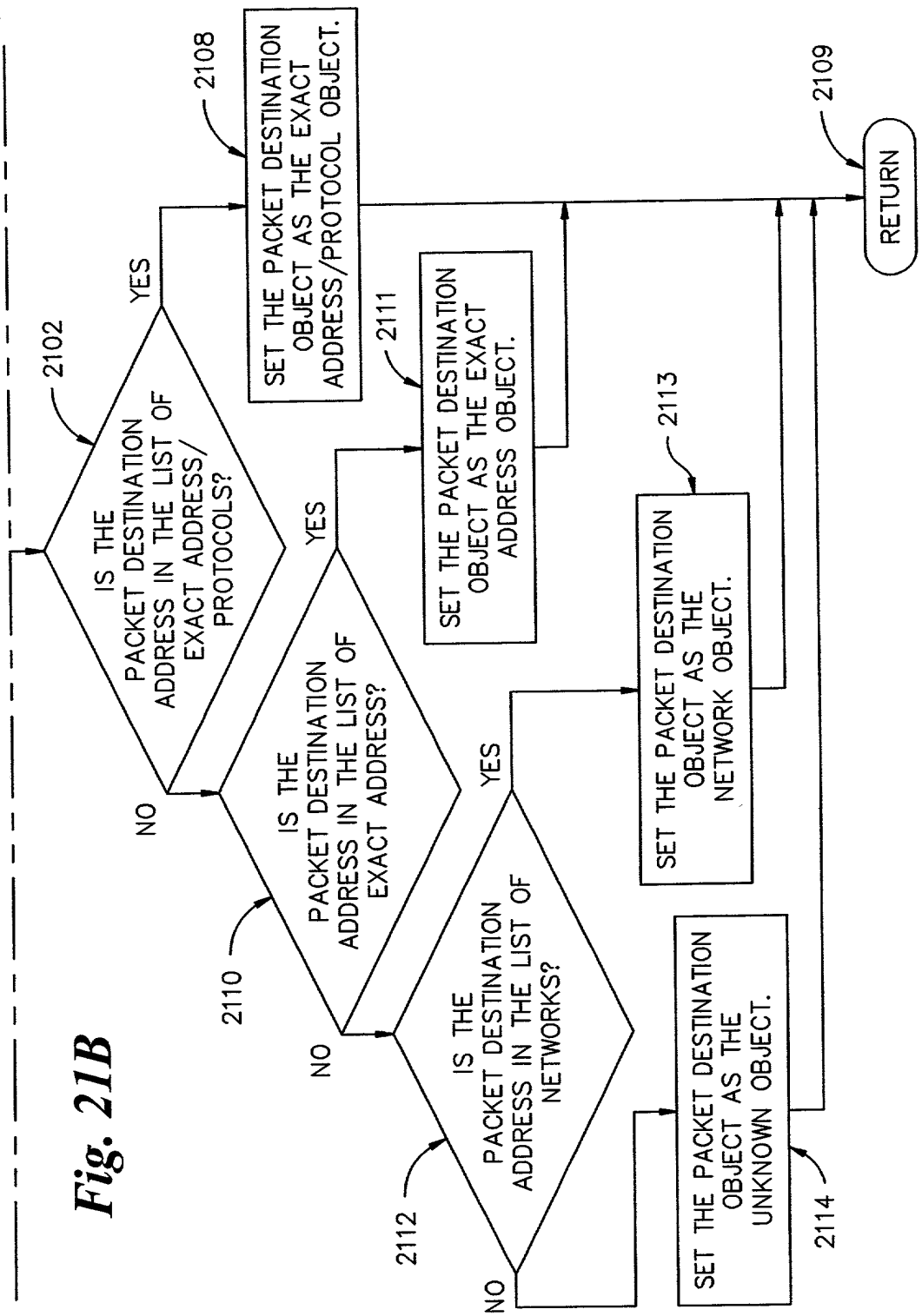
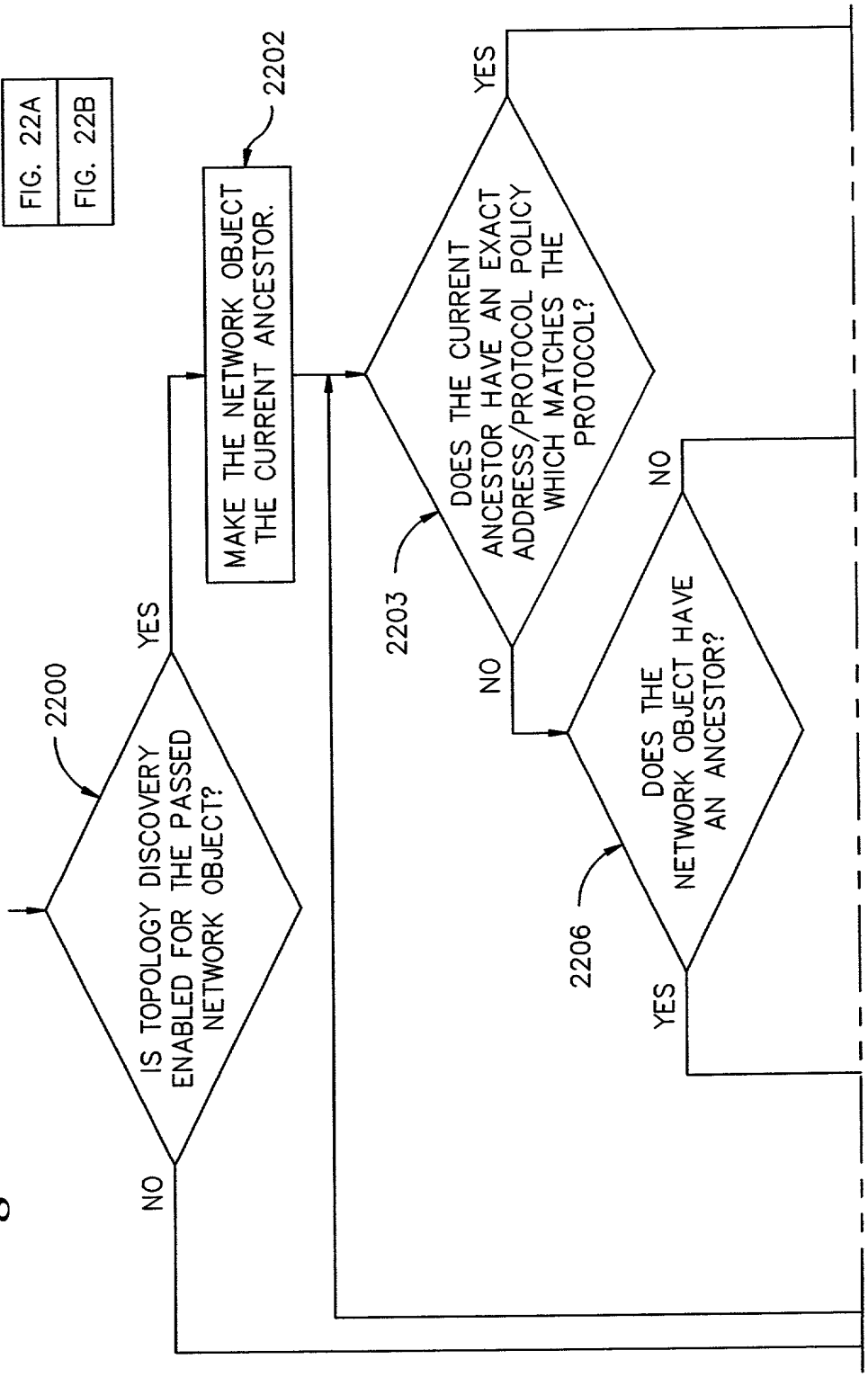


Fig. 21B

TO2007052860

Fig. 22

Fig. 22A



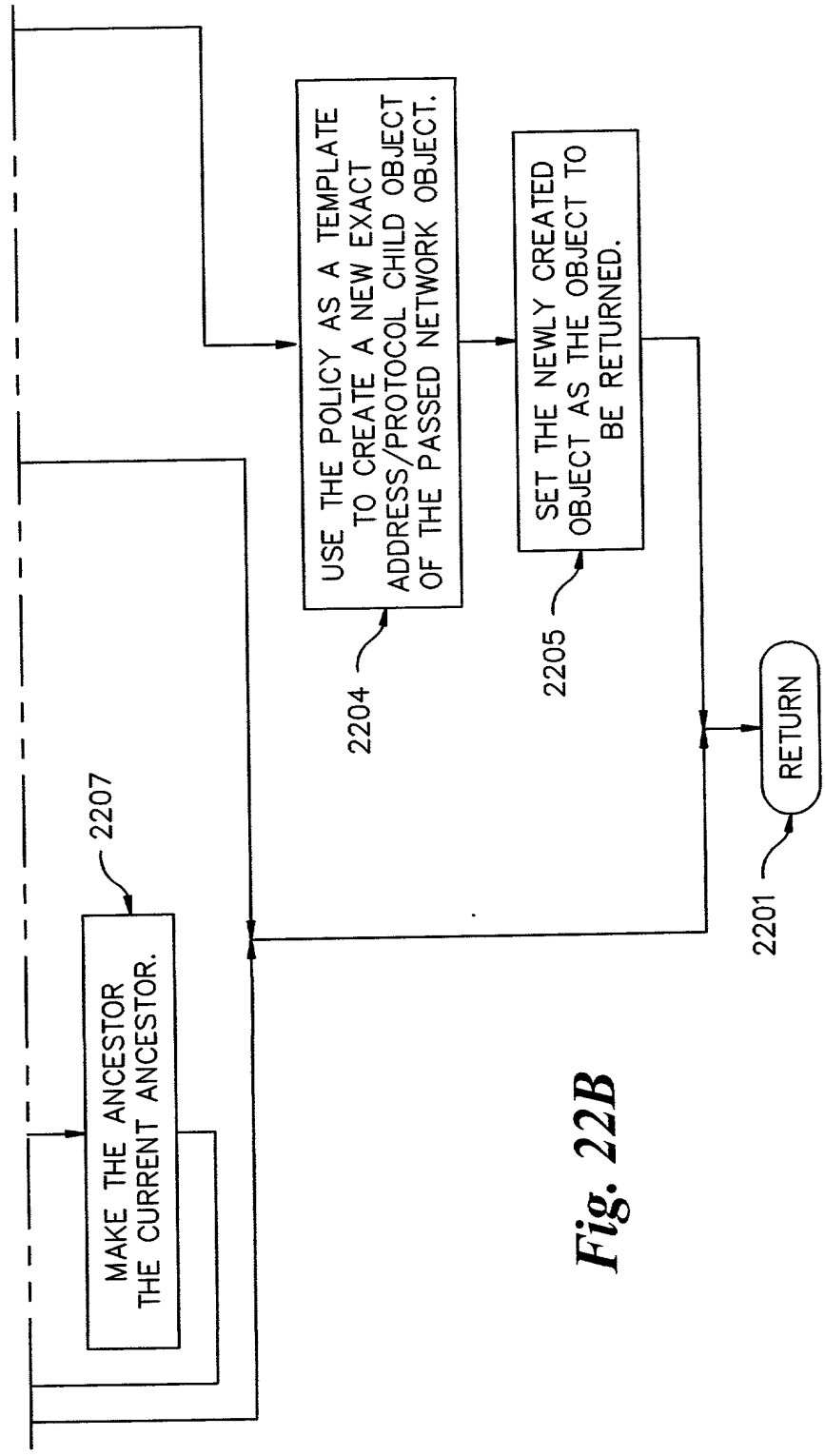
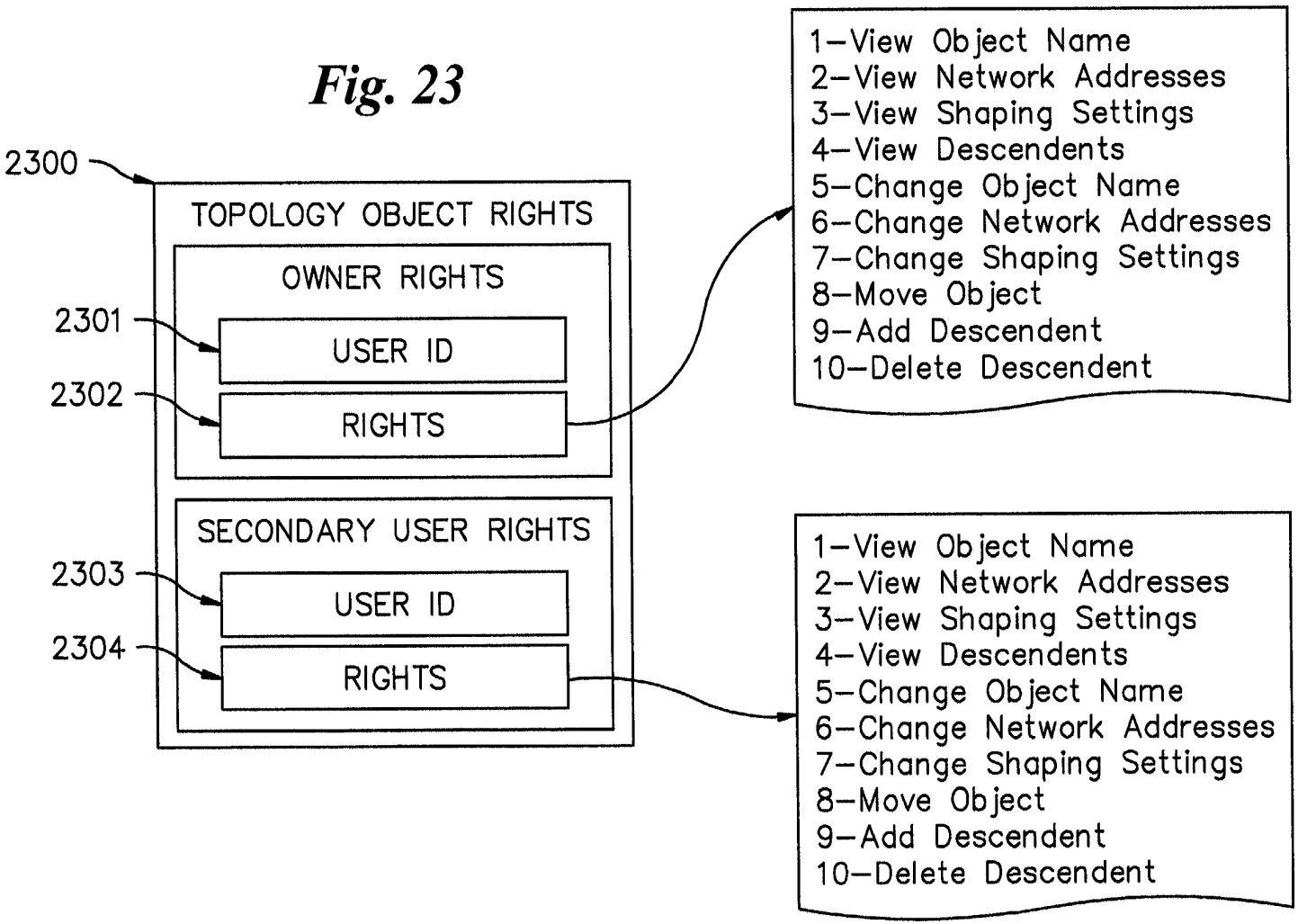

MAKE THE ANCESTOR THE CURRENT ANCESTOR.
2207
USE THE POLICY AS A TEMPLATE TO CREATE A NEW EXACT ADDRESS/PROTOCOL CHILD OBJECT OF THE PASSED NETWORK OBJECT.
2204
SET THE NEWLY CREATED OBJECT AS THE OBJECT TO BE RETURNED.
2205
RETURN
2201

Fig. 22B

Fig. 23


2300
TOPOLOGY OBJECT RIGHTS
OWNER RIGHTS
2301
USER ID
2302
RIGHTS
SECONDARY USER RIGHTS
2303
USER ID
2304
RIGHTS
1–View Object Name
2–View Network Addresses
3–View Shaping Settings
4–View Descendents
5–Change Object Name
6–Change Network Addresses
7–Change Shaping Settings
8–Move Object
9–Add Descendent
10–Delete Descendent
1–View Object Name
2–View Network Addresses
3–View Shaping Settings
4–View Descendents
5–Change Object Name
6–Change Network Addresses
7–Change Shaping Settings
8–Move Object
9–Add Descendent
10–Delete Descendent

WO 2004/028050 PCT/US2003/029650

Fig. 24A

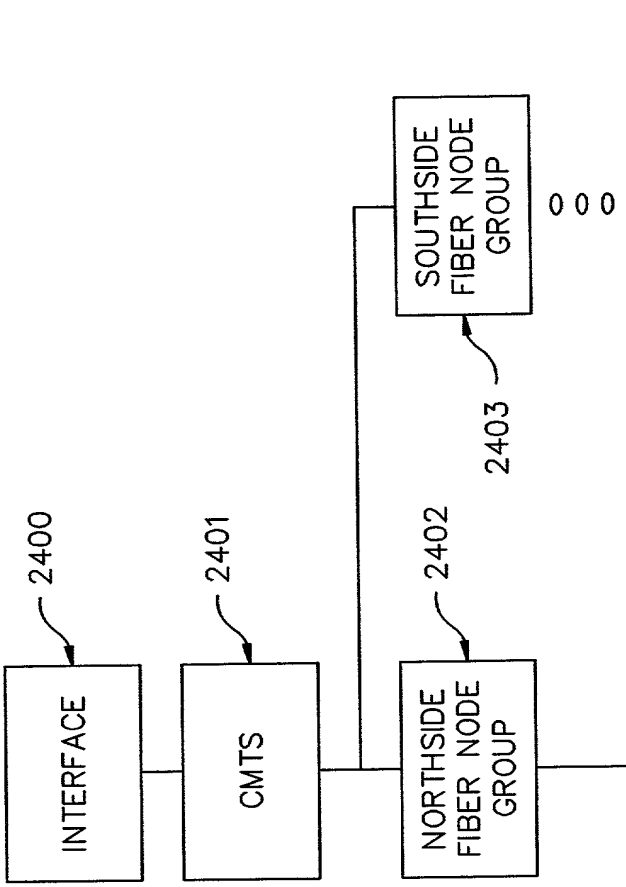


Fig. 24

FIG. 24A
FIG. 24B

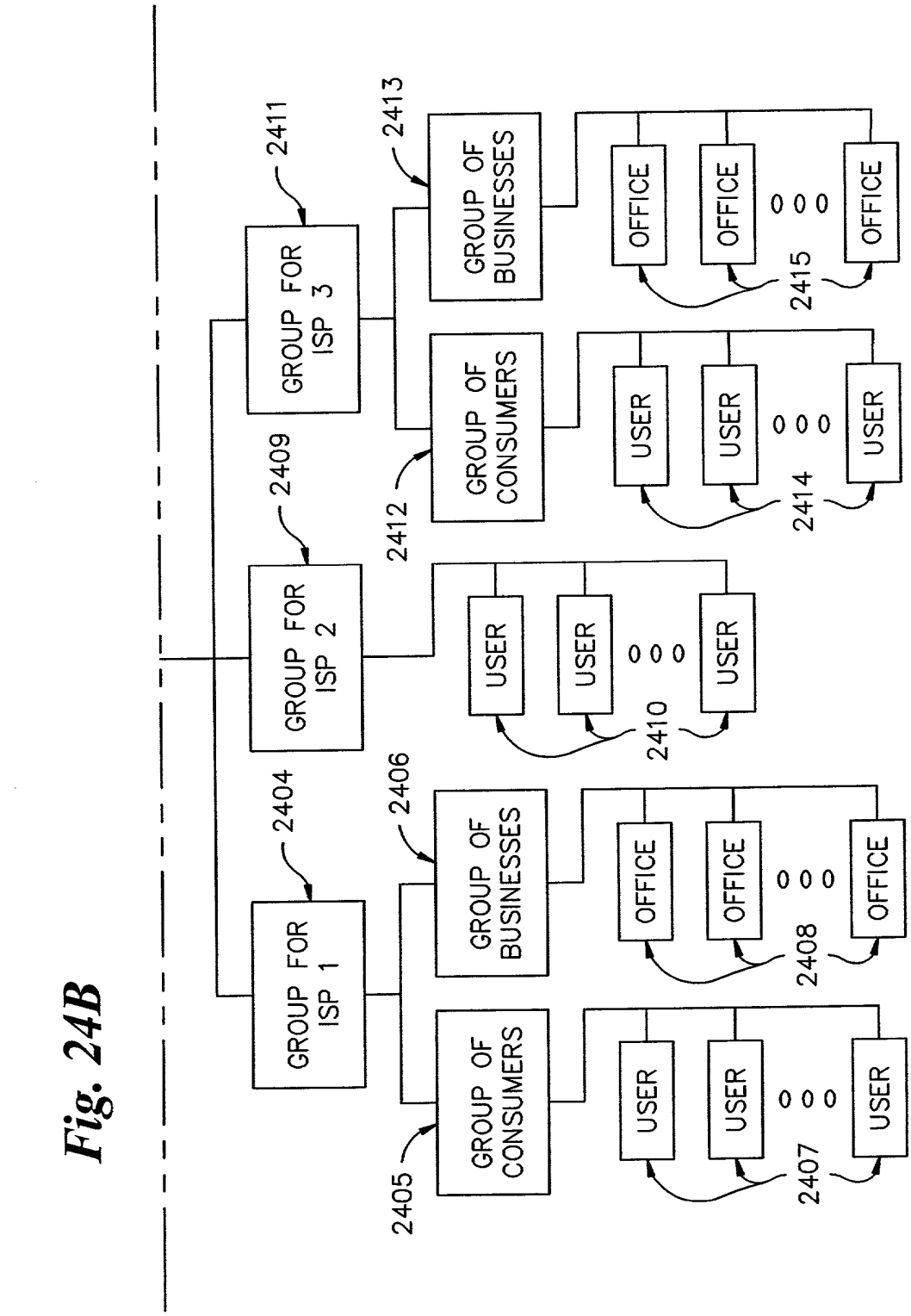

GROUP FOR ISP 1
GROUP FOR ISP 2
GROUP FOR ISP 3
2404
2409
2411
GROUP OF CONSUMERS
GROUP OF BUSINESSES
GROUP OF CONSUMERS
GROUP OF BUSINESSES
GROUP OF CONSUMERS
GROUP OF BUSINESSES
2405
2406
2412
2413
USER
OFFICE
2407
2408
2410
2414
2415

Fig. 24B

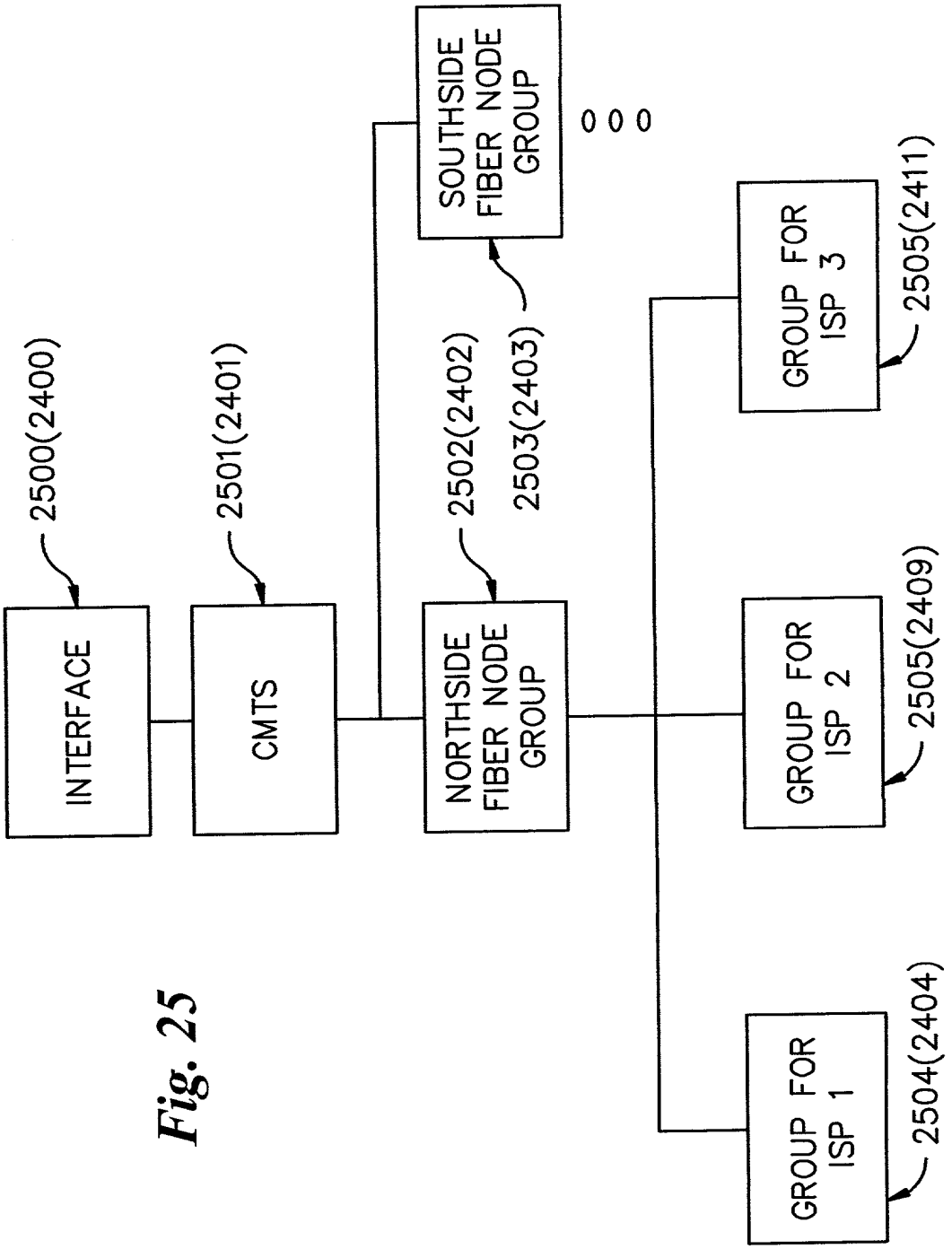

INTERFACE
2500(2400)
CMTS
2501(2401)
NORTHSIDE FIBER NODE GROUP
2502(2402)
SOUTHSIDE FIBER NODE GROUP
2503(2403)
000
GROUP FOR ISP 1
2504(2404)
GROUP FOR ISP 2
2505(2409)
GROUP FOR ISP 3
2505(2411)

Fig. 25

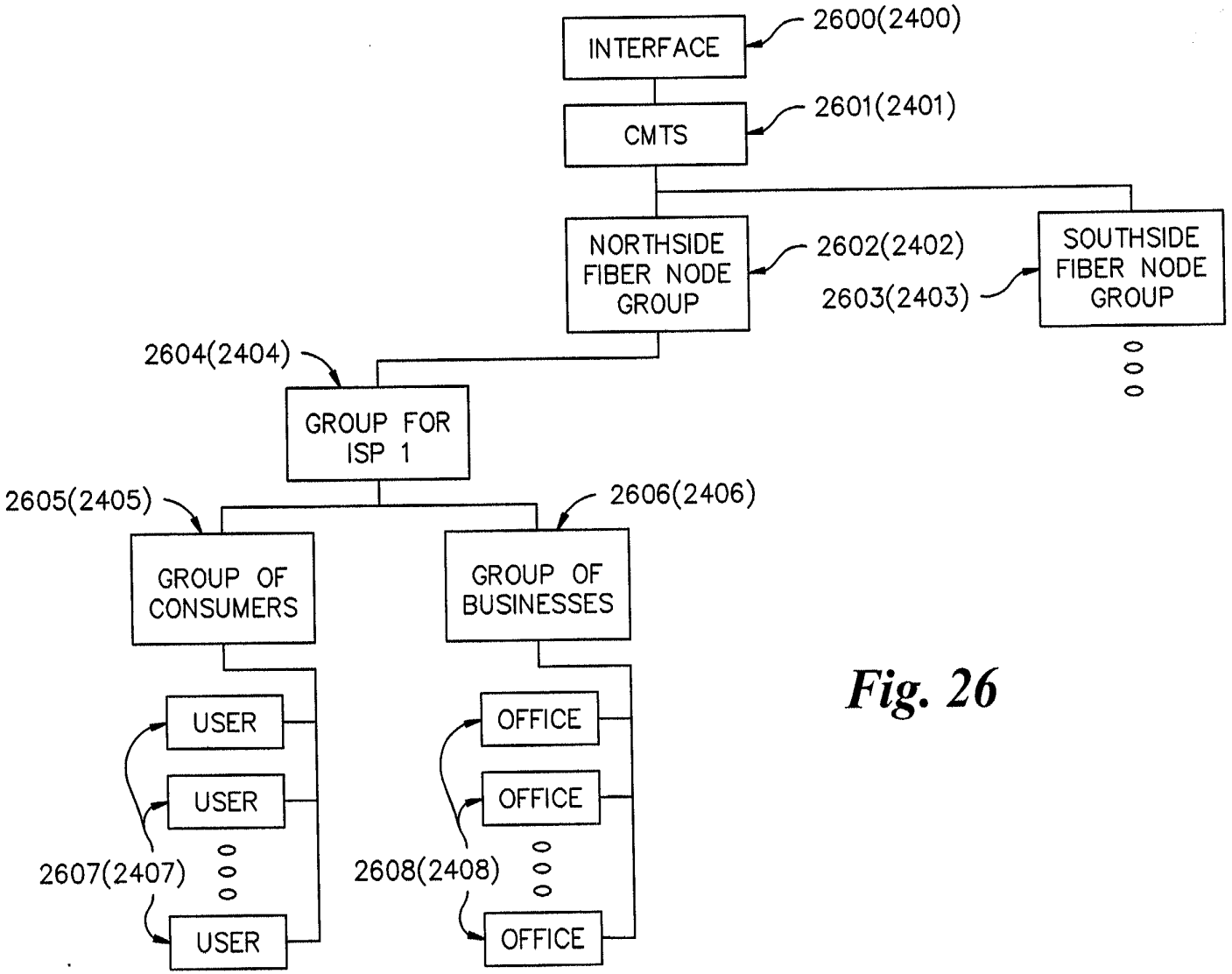

INTERFACE
2600(2400)
CMTS
2601(2401)
NORTHSIDE FIBER NODE GROUP
2602(2402)
2603(2403)
SOUTHSIDE FIBER NODE GROUP
2604(2404)
GROUP FOR ISP 1
2605(2405)
2606(2406)
GROUP OF CONSUMERS
GROUP OF BUSINESSES
USER
USER
USER
2607(2407)
OFFICE
OFFICE
OFFICE
2608(2408)

Fig. 26

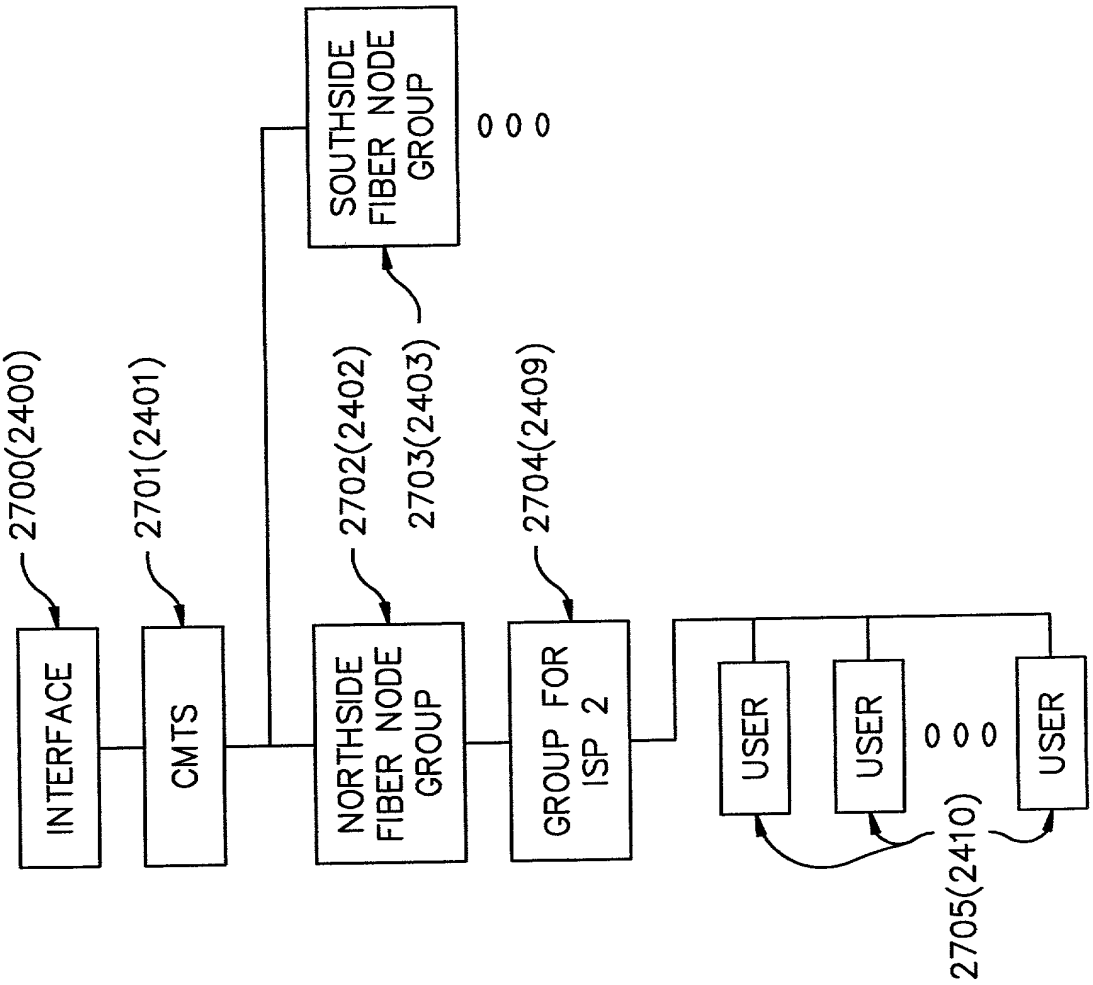

2700(2400)
INTERFACE
2701(2401)
CMTS
2702(2402)
NORTHSIDE FIBER NODE GROUP
2703(2403)
SOUTHSIDE FIBER NODE GROUP
000
2704(2409)
GROUP FOR ISP 2
USER
USER
000
USER
2705(2410)

Fig. 27